INDEXED.

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THE RIGGING OF AMERICAN SAILING VESSELS.

BY FRED M. COOK.

The subject of spars, sails, and rigging, in the days when wind alone was used for the propelling power of vessels, was considered one of the most important factors in the design of ships; while in these times of steam and electricity this subject, as one of importance, has often been neglected, resulting in vessels, which otherwise would be good-looking to the eye of the sailor, being made hideous by masts and rigging so located and proportioned as to completely spoil the symmetry of appearance that pleases the nautical eye. This is particularly noticeable in a great many steam yachts—a class of vessels where appearance is considered of prime importance.

Of the various rigs used for sailing vessels, the four-masted ship, or, correctly speaking, the shipentine, is the grandest vessel that ever sailed the seas. These vessels are at present used mostly in the trade between San Francisco and European ports, returning by way of New York or Baltimore, or in carrying case oil to Asiatic ports from the oil centers of the United States. The grand fleet of three-masted ships and barks are fast disappearing from the seas or being converted into

MODERN FOUR-MASTED SHIPENTINE ASTRAL.

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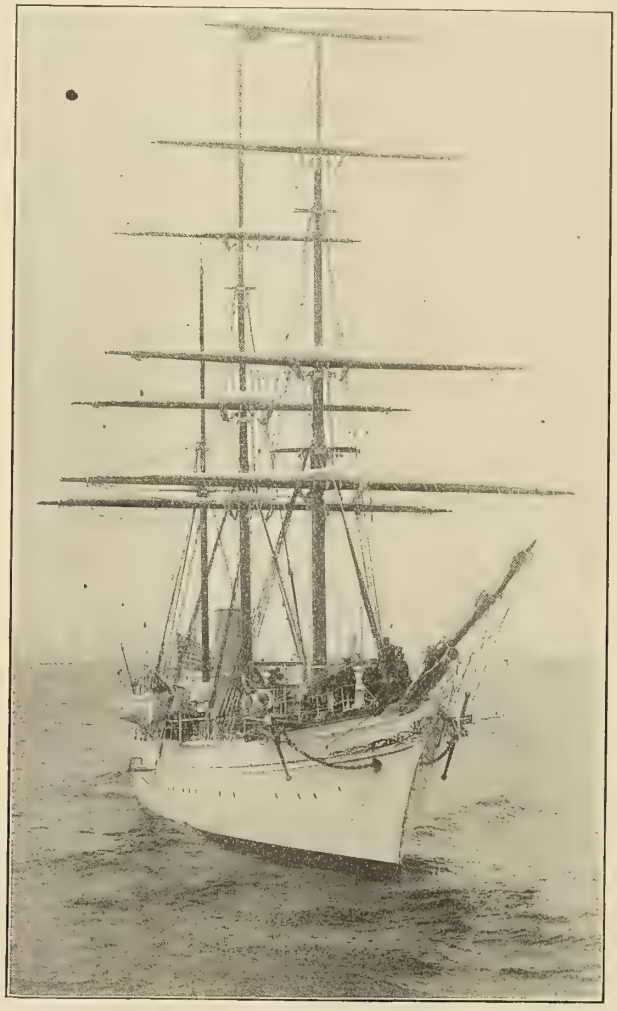
barges, as, in the competition with the tramp steamer, only the ship of very large cargo capacity can be run profitably, and then only on long trips. The American schooner will, in all probability, for a great many years to come hold its prestige for the coastwise bulk cargo trade of the Atlantic coast, and a few of these vessels are at present engaging in the offshore trade. This class of vessel has proven very profitable in most cases, and some equal in size the largest square-riggers afloat.

There are numerous other rigs used for various trades, such as the barkentine, the topsail schooner, the sloop, the yawl, etc.



AUXILIARY STEAM YACHT WHITE HEATHER; BARK RIG.

[Photograph by E. Muller.]

The modern steamer for merchant service carries very few sails, and those only for steadying purposes in a seaway. A great many of the latest steamers only carry masts for derrick uses in handling their cargoes.

The masts of this class of vessel being mostly of steel construction, the rigging connections are usually formed by forged bands with eyes and fitted to set down on a butt lap of plating, or by heavy pad eyes riveted to mast, into which the shrouds and stays are shackled; the stays, being single, are spliced over thimble in shackle, while the shrouds are worked in pairs, the shackle being in the bight with heavy wire seizing to prevent the bight slipping. Wire rope is used entirely for all standing rigging, and is usually served, though in some cases this is omitted. Where hemp ratlines are used it is desirable to have serving to prevent them from slipping down. Sometimes the shrouds are served, and not the stays, except over the splicing at the ends. The lower ends of the shrouds are spliced over cast hearts with two holes, the upper to take the sheer pole and the lower one to take the turnbuckle. The turnbuckles are fitted with jaws in both ends, and a lock nut to prevent the buckle from loosening up when the ship is thrashing in a seaway. The backstays are usually set up in the same way as the shrouds, with the omission of the sheer pole. On the headstays the turnbuckles are omitted and the stay is set up on end, which is, that the end is rove around a thimble in a shackle, turned up and lashed, the end of the rope being covered with a brass cap to prevent unlaying.

Where wood topmasts are used the rigging can best be connected by an eye splice around same, supported by a funnel or bolster to prevent working down.

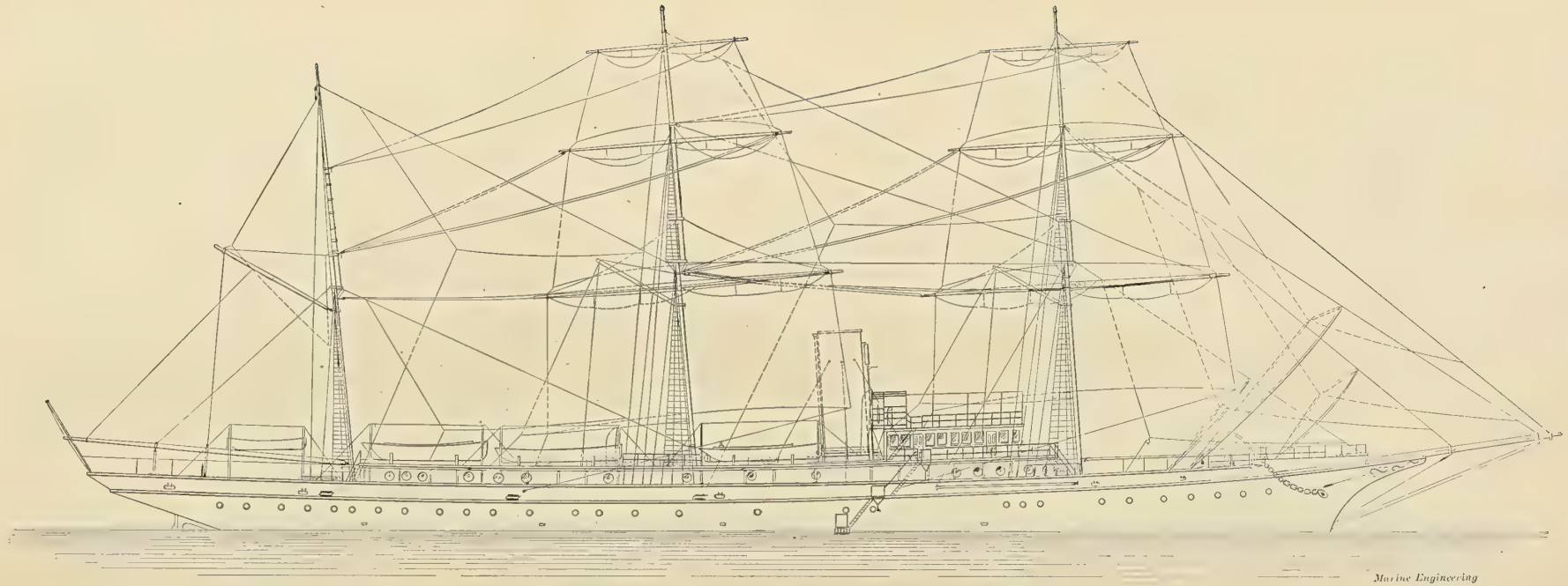
The sparring and rigging of the steam yacht are

important features in her make-up and should receive careful consideration by the designer. It is impossible to go by any strict rule for locating and giving length for the spars of this class of vessel, as there is such a variety of styles and make-up of hulls and also the different requirements and fancies of the prospective owners.

A RELIC OF THE OLD DAYS, THE NAUTICAL TRAINING SHIP ST. MARY.

[Photograph by E. Muller.]

One of the handsomest specimens of this class of rigged steam yachts is the *Aphrodite,* built and designed by the Bath Iron Works, of Bath, Me., a description of which may be of interest. This yacht is 302 feet long and is rigged as what is called amongst sailors the "jack-ass bark" rig; that is, bark rig with the fore and main masts the same length instead of the main being longer,



RIGGING PLAN OF THE STEAM YACHT APHRODITE; BARK RIG.

as is usual in the bark rig. She is fitted with courses, single topsails, and topgallant sails on the fore and main, with a fore-and-aft spanker and working gaff topsail on the mizzen; main and mizzen and mizzen-topmast staysails and three jibs. The following is a list of the sizes of wire rigging used on this vessel:

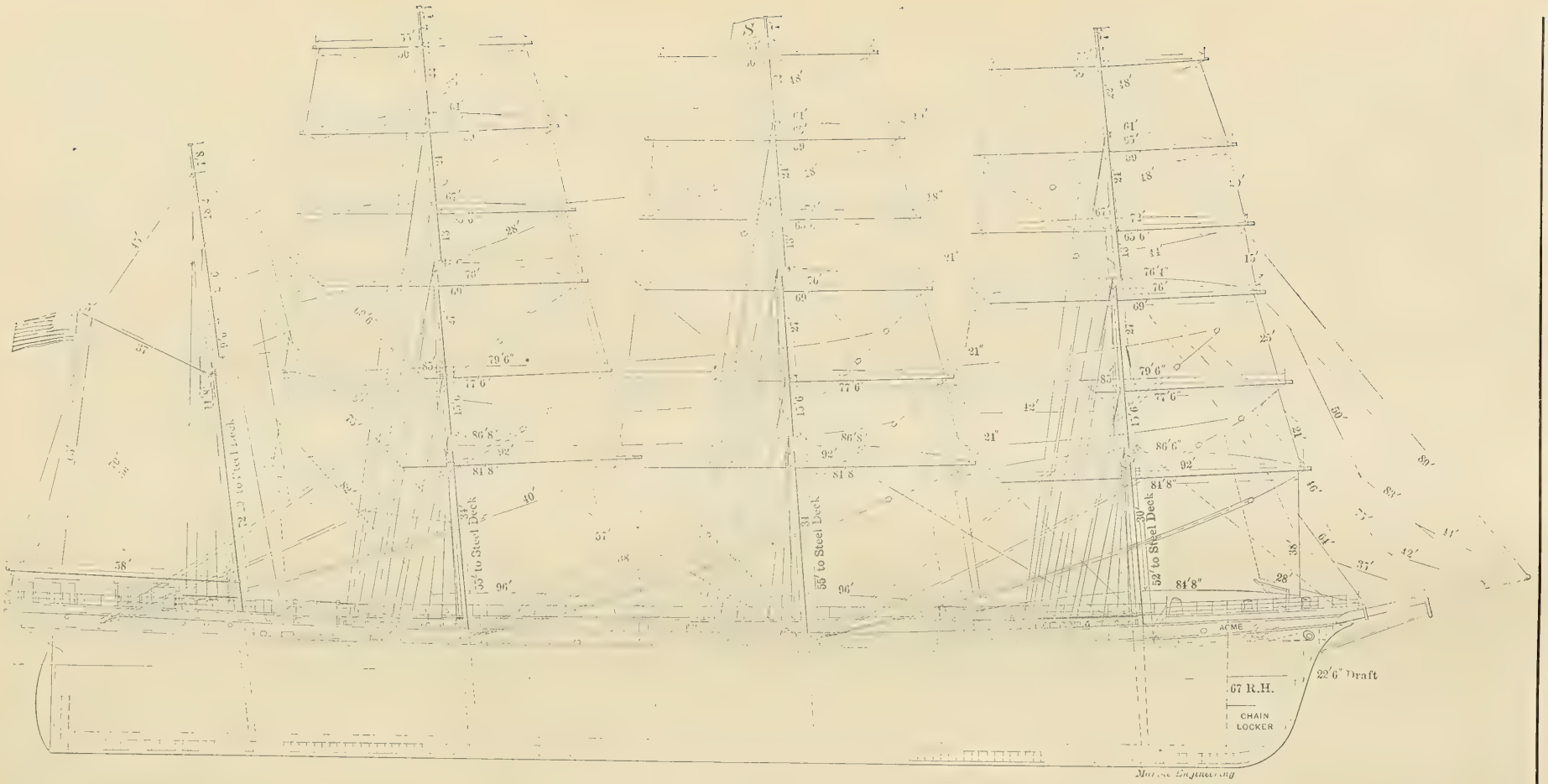
	Inches circumference.
Fore and main shrouds	3¼
" " " backstays	3
" " " topgallant backstays	2¾
Mizzen shrouds	3
" topmast backstays	2½
Fore topgallant stay	2½
Flying jibstay	3
Jibstay (double)	3
Forestay	3¾
Main topgallant stay	2¾
" topmast stay	2¾
Spring stay	2¾
Mizzen topmast stay	2¾
Mizzen stay	3¾
Peak lifts (standing gaffs)	3
Topmast rigging (all masts)	2
Topgallant lifts	2
Topsail "	2½
Topgallant foot ropes	2
Topsail " "	2¼
Fore and main foot ropes	2¼
Flemish hawsers	2
Foot-rope stirrups	2
Vangs	2
Inner jibboom guys	3
Outer " "	2¼
Middle " "	2¾
Ridge ropes	1¾
Boat davit guys and spans	1¾
Dinghy davit guys and spans	1½
Stack guys	2¼
Outer bobstay	3
Inner "	1½ inch diameter solid rod

The most interesting class of vessels, as regards spars and rigging, are the sailing vessels of the merchant marine. The leaders of these are the beautiful four-masted square-riggers engaged in the deep-sea trade. Most of these vessels have, as previously mentioned, what is commonly known as the shipentine rig, with square rig on the fore, main, and mizzen masts and fore-and-aft rig on the spanker mast. On the larger vessels of this type it has been found best to fit double topgallant sails as well as double topsails to facilitate handling in heavy weather, though the old way of single topsails and topgallant sails was in all probability the faster rig. On a vessel of this rig the yards of the courses, lower topsails, and the lower topgallant sails are fixed, while the other yards hoist. The masts are usually fitted in three sections, namely, lower mast, top-mast, and with the topgallant and royal in one piece,

though in some of the latest steel ships with steel spars the lower and top masts have been made in one section, making only one doubling for the entire spar. The topgallant and royal masts are usually of wood. Owing to the great saving in weight, as well as increased strength, steel is being used almost entirely for the larger spars on the larger class of square-riggers.

THE PASSING TYPE OF THREE-MASTED WOODEN SHIPS.

On these vessels the fore, main, and mizzen are practically duplicates as regards sails, so that in describing the fittings for one we have them all. The lower yards are secured to the mast by what is called a truss, composed of a pinchband on mast, fitted with double flat links on forward side, between which a heavy forged arm is worked, connected to the links by a through bolt, forming a horizontal joint, allowing the yard to swing sideways for trimming the sails; this arm, about thirty inches long, connects to a yoke on the yard by passing through with a shoulder, forming another joint, allowing the yard to swing vertically, or what is known as "cockbilled." This yoke is connected to the yard by two heavy pinchbands. The weight of the yard is carried by a heavy chain sling leading from an eye under



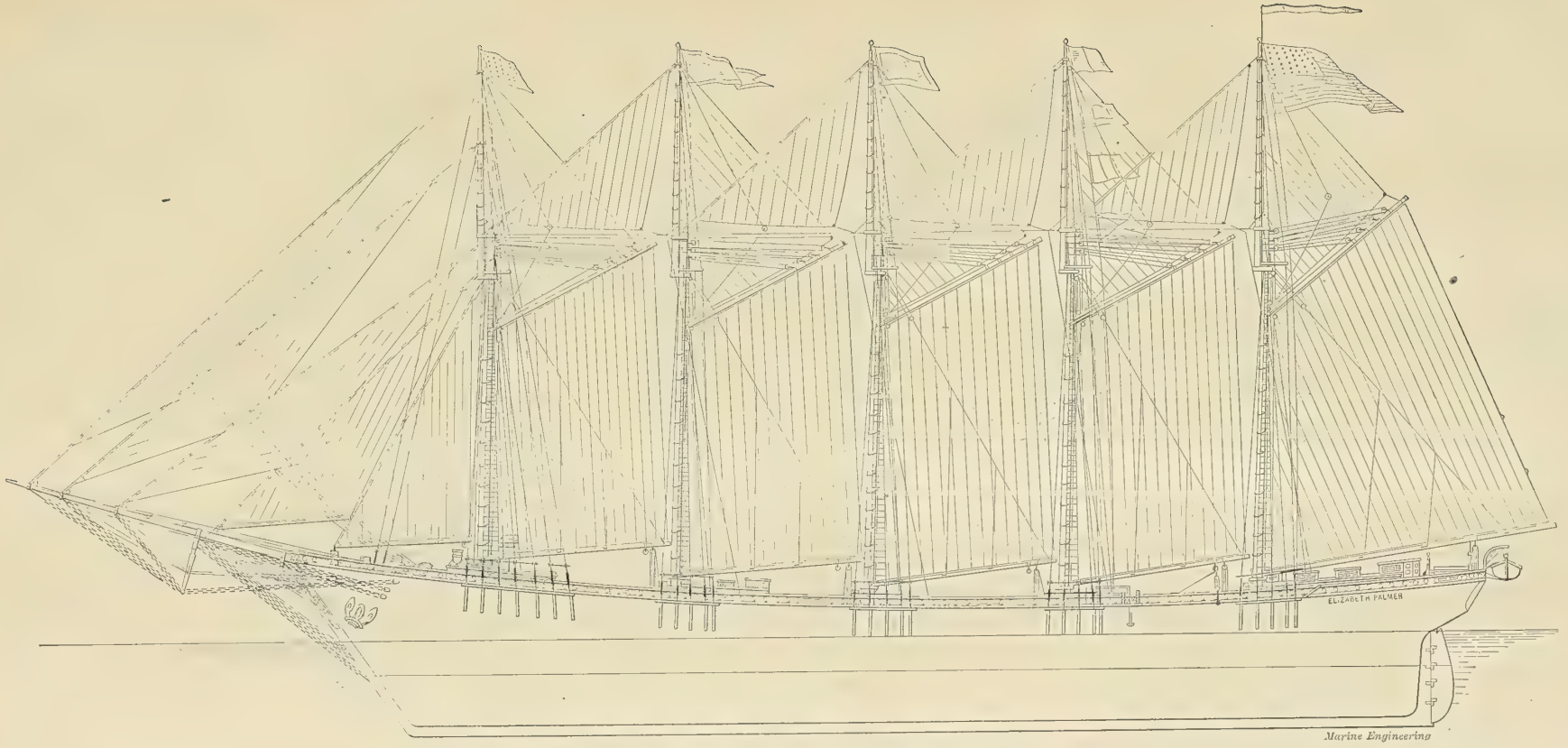
SAIL PLAN OF THE FOUR-MASTED SHIPENTINE ASTRAL.

the top to a band located on the yard at center between the two yoke bands.

The lower topsail yard is usually carried by a truss similarly constructed, but made to span the topmast doublings, and located about one foot below the cap band. The weight of this yard, when double topsails are used, is taken by a forged strut from an eye on the top to a band at center of yard. When single topsails are used the weight is carried by a sling from the topmast head. The arrangement for lower topgallant yard is the same as for lower topsail, except that it is of lighter scantling.

The remainder of the yards are fitted with what are called tubs—that is, with a heavy wood chock fitted to yard and reaching half-way around mast, with a heavy forged bail around the remainder of the mast, and all covered with leather for chafing. This is a loose fit around mast, that it may work easily even if the yard is slightly canted. The ends of the bail are secured to wood chock by a hinge joint, so that by drawing the pin at one end the bail can be swung open, and the yard unshipped.

All yards are fitted with rod jackstays on top side, to which the sails are bent. These rod stays pass



SAIL PLAN OF FIVE-MASTED SCHOONER ELIZABETH PALMER.

through small forged screw eyes on the yard. The yards are also fitted with eyes for foot ropes, foot-rope stirrups, etc., and band at each end with eyes for the lifts, clews, and braces, also bands at ends of arms for reefing.

The after or spanker mast of these vessels is usually fitted similar to a schooner, except that the lower mast is rather short and a topgallant mast is carried. The top and topgallant masts are used more for leading the braces of the mizzen upper yards to, than for supporting sails, though a gaff topsail is usually carried. A top is not fitted to this mast, but in its place is fitted trestletrees similar to the fore, main, and mizzen top, and topgallant doublings with the omission of the spreader.

Some of the latest American vessels of this rig have rather a peculiar arrangement of sails for this mast, the spanker being fitted in two sections, the split being from throat to clew. By this arrangement, when sail is shortened the upper section is taken in, leaving a three-cornered or leg-of-mutton sail, which makes a very convenient sail for heavy weather, especially when it is necessary to lay-to. When rigged this way the gaff is fixed and is fitted with a gooseneck, and is located at the masthead cap instead of only hoisting to about six feet below the hounds, as by the old arrangement of hoisting gaff.

The spanker boom is fitted with a gooseneck at mast, which is usually composed of two pinchbands on mast, about six inches apart, with lugs on after side through which passes a heavy bolt connecting the bands. On this bolt between the bands a forging is fitted which allows the boom to swing. This forging connects to

the pacific iron on the end of the boom by a hinge joint, allowing vertical swing. The pacific iron is a split cap over end of boom, with lug on end for connection to the hinge joint, and is through-riveted to the boom. This boom also has a sheet band and a band at end with eye for hauling out the clew. The sheet band is a two-section pinchband with the bolts in one piece, forming a U-shaped bail on the under side for the sheet block to travel on.

These vessels carry what is known as a spike bowsprit—that is, all in one piece and of round section, constructed of steel. The plating is arranged so that the butt laps form shoulders for the bands that take the jib and bobstays. The bands are usually fitted with double lugs on top side, with bolt and thimble between. Over these thimbles the stays pass, setting up on end at the knightheads. These bands also have lugs on bottom and sides for taking the bobstays and bowsprit shrouds. The bobstays are generally of solid rods with shackle connection at stem, and the bowsprit shrouds of wire rope with turnbuckles at the bow quarters.

The matter of hull connection for the standing rigging of a ship of this class is very important. The combined working strength of the standing rigging of a vessel of this class is about two thousand tons, which gives some idea of the enormous strains on the hull connections. The shrouds and backstays connect to the sheer strake by heavy pad-chain plates located on inside of bulwarks. These shrouds and backstays are fitted with turnbuckles above the sail for setting up. The mast and topmast stays set up on end at heavy pad eyes located on deck at foot of the mast, the forward one being stayed.

TYPE OF MODERN FISHING SCHOONER.

The most important class of sailing vessels in the American merchant marine of the present day are fore-and-aft schooners of the coasting fleet. These vessels are very popular on account of their simplicity of rig and economy, being manned by a crew of about half the number required for a square-rigger of the same tonnage. The sails of these vessels, while very large in the case of the larger ones, are very easily handled, as the work can be done almost wholly from the deck, work aloft only being necessary in furling the gaff topsails and topmast staysails, which sails are not usually carried in heavy weather. The advent of the steam hoister has also proven a means of great economy for this class of ships.

The majority of these vessels are of wood construction with wood spars. The lower masts are of Oregon pine; the topmasts, jibboom, booms, and gaffs of spruce or Oregon pine; and the bowsprit of yellow pine. The masts are fitted with wood trestletrees at the hounds for taking heel of topmasts, supported on forward side by heavy oak chocks or supporters for carrying the weight. Wood spreaders are fitted on top of the trestletrees for the topmast backstays. At the masthead a heavy forged cap is fitted and securely fastened by through bolts to the head, and has band on forward side for taking the topmast. At the topmast head a shoulder is worked in the spar, on which a tapered band sets. Over the top of this band sets a round forged

A FULL-SAIL BREEZE.

grommet, and the topmast rigging is fitted with spliced eyes and dropped over head and rests on this grommet, which, being of round section, prevents cutting of same. At the head of the topmast pole a band is fitted with eyes for taking stays and signal halyards. The booms and gaffs are fitted with oak jaws at masts and forged bands for taking sheets and clews.

The bowsprit is of square section and built up of yellow-pine timber, and is fitted between knightheads at bow, and steps in heavy wood bitts under the forecastle deck. At outer end a heavy cap band is fitted to take the jibboom, and has an eye on under side for taking the martingale or dolphin striker, which acts as a spreader for the jibboom bobstays, which are usually of chain. The bowsprit bobstays are of heavy chain, usually two in number, and connecting to stem of vessel by heavy forged straps through-riveted to stem. A turnbuckle is fitted at outer end of each for setting up.

The shrouds are worked in pairs, passing around masthead over bolsters on trestletrees and seized. The chain plates are in the form of heavy straps on the outside of the vessel, securely fastened to the plank and framing. Turnbuckles are fitted above rail, with the sheer pole lashed to upper end, or with rod passing through the hearts in the splices at ends of the wire rope. The backstays are fitted in a similar manner to the shrouds, with the omission of the sheer poles. All the standing rigging is of galvanized wire rope, and, with the exception of stays on which sails slide, is usually served with marline.

The topmast rigging leads to ends of trestletrees and sets up with deadeyes and lanyards, with futtock shrouds of solid bars to a band on mast about six feet below the hounds. The bowsprit and jibboom shrouds or guys set up at the catheads with turnbuckles.

Among the smaller vessels of this rig are found some handsome and seaworthy craft, such as fishermen, pilot boats, and yachts. These are usually two-masted vessels, with the masts set well forward and the foremast somewhat shorter than the mainmast. This arrangement gives a larger mainsail, which helps the sailing qualities, especially in windward work.

Turbine Channel Steamer Brighton.

There was recently placed on the New Haven-Dieppe service across the English channel a new steamer named the *Brighton,* built by William Denny and Brothers, Dumbarton, and fitted with Parsons steam turbines. The hull of the *Brighton* measures 282 feet by 34 feet by 15 feet 2 1-2 inches, and the gross tonnage is 1,130 feet. She is but slightly larger than the *Arundel,* hitherto the finest boat of the fleet, which is 277 feet and of 1,060 gross tons register. The latter boat has accommodations for about 900 passengers, while the *Brighton,* because of her slightly increased size and the smaller space devoted to engines, will carry a hundred more.

There is one high-pressure turbine, set on the center line of ship, designed to run at 700 revolutions per minute, driving a single screw; and two low-pressure wing turbines, each driving a shaft and single screw at about 500 revolutions. Reversing turbines are fitted at the after end of each low-pressure turbine. The arrangement is similar to that of the *Queen,* described in the September, 1903, issue of Marine Engineering. Steam is supplied from four single-end boilers designed for a working pressure of 150 pounds. The entire lubrication is automatic, and it is said that the consumption of oil is practically negligible in comparison to that on the *Arundel.* The engine room is remarkably small for the power of the engines, but, apart from the auxiliaries, there is nothing whatever to be seen in it save the turbine casings, the shaft, and the pipes. Condensers are placed between the low-pressure turbines and the side platings of the vessel, the cooling water being circulated by centrifugals driven by small compound, inverted engines which also drive the air pumps. Though more powerful than the engines fitted in the *Arundel,* the adoption of the turbine has enabled the owners to reduce the engine-room staff by two. The *Brighton* is very handsomely fitted up for day and night service, with large cabins forward for first-class passengers. The after end of the ship is devoted to second-cabin accommodations.

The chairman of the Southeastern Railway Company, owners of the turbine channel steamer *Queen,* has stated that although nine minutes quicker than the *Victoria* and the *Empress,* the two most recent twin-screw reciprocating-engine vessels, the *Queen* only burns the same amount of coal, and has four men fewer in the engine room.

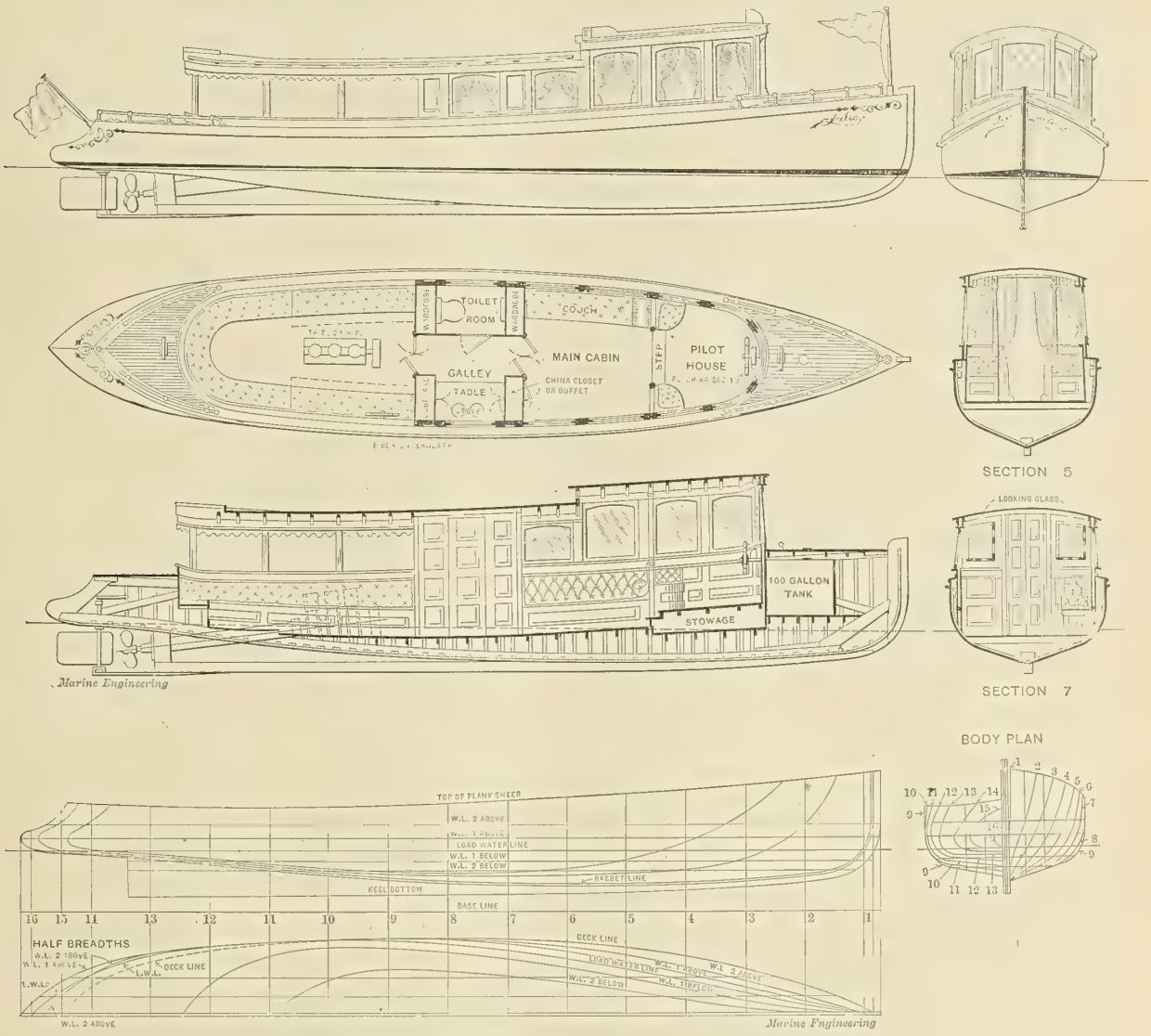
Electric Haulage on Canals.—In a recent issue of the *Revue Technique,* M. Georges Petit gives an interesting discussion of electric haulage on canals. Recognizing that the principal problem was one of traction, it is necessary to consider two methods—one in which the motor travels on an ordinary road, and the other in which it runs on rails. The first system gives a higher tractive effort for a given weight of motor, but it takes more power to move the motor itself, and the efficiency of the system is less than when the motor runs on rails. In studying the problem, the power required to overcome the inertia of the boat is easily computed from its known weight. That, however, required to overcome the friction of water when confined in a canal could only be determined experimentally, and, to do this, boats were brought up to a known speed and were then allowed to drift after the tractive force had been cut off, their rate of retardation being noted. From the retardation curves and the computed inertia, acceleration and power curves were constructed, both for motors traveling on an ordinary roadbed and on rails. The results show that the rail system is superior to the other, and that it will be less expensive to keep up, although the first cost will be greater. It is the author's opinion that mechanical haulage on canals will surely be adopted in the future, and he believes it will be entirely successful. Moreover, the systems will be operated electrically, because this is the most efficient and reliable method of supplying the power.—*Electrical Review.*

Errata.—In the December, 1903, issue of Marine Engineering, on page 623, column 1, line 11, correct *Celtic* to *Minnesota;* also page 635, column 2, second line above cut, correct 68 to 65.

Half-Cabin Cruising Launch.

The drawings on this page are of a 41-foot half-cabin cruising launch, designed by the Wolverine Motor Works, of Grand Rapids, Mich., for Mr. Morris Shanahan. The purpose of the design was to have made a good, comfortable cruising launch, and, at the same time, to have a large, open cockpit and give the boat a good speed.

intercepts the water line at the stern. As will be seen from the lines, full buttocks are carried well aft and the center of the water planes makes a raking midship section. A heavy deadwood is carried aft to support the propeller and rudder and to give a strong backbone to the boat. Deck floors are worked in forward. The planking is of 1 1-8-inch cypress, and it is evident that the boat is strongly built.



CONSTRUCTION PLANS AND LINES OF A 41-FOOT HALF-CABIN CRUISING LAUNCH.

The general dimensions of the boat are:

Length on deck, 41 feet.

Length on water line, 43 feet.

Beam over all, 7 feet 8 inches.

Maximum draft of hull, 1 foot 10 inches.

Extreme draft, light, 2 feet 5 inches.

The freeboard is 4 feet 3 inches, dropping to 2 feet 4 inches at the stern, while the lowest point of the sheer is but 2 feet 11-2 inches above the water line. The greatest depth of the hull is forward at about the fifth section, rising by an almost flat curve aft till it

A gasoline tank, containing 100 gallons, is stowed forward of the pilot house. The floor of the pilot house is raised; large plate-glass windows are on front and sides. In the cabin a couch is fitted on the port side, all upholstery being of plush, while the curtains and the portieres are of damask. The finish of deck and cabins is in mahogany. Amidships are lockers, toilet room, cupboard, and galley, while in the open cockpit aft is placed a 3-cylinder, 18-horse-power Wolverine motor.

The boat is to be used in Miami, Florida, on the coast and inland bays.

SHIPYARD ECONOMIES.—I.

BY R. S. HUBBARD.

At a time like the present, when the very existence of the American shipbuilding industry is seriously threatened by conditions which are beyond the control of the shipbuilder, there is a natural tendency to abandon the consideration of ways and means of effecting economies in production under the stress of anxiety about the future.

While, however, the prospect is gloomy with respect to construction of vessels for the oversea carrying and passenger trades, owing to the present unfortunate position of shipowners and the comparative dearness of labor and materials in this country, the future of warship building by contract with the government, and that of construction for business and pleasure traffic in home waters, appears to depend largely upon the ability of shipbuilders to carry out their work with efficiency and economy.

While economy is, or ought to be, the lifelong study of those who undertake the responsibilities of organization and supervision, and is as necessary in times of the greatest prosperity as in times of depression, it generally happens that such means of inaugurating economies as changes in organization, alterations to and improvements of plant and reductions of wages, can most conveniently be taken advantage of when, as at present, the personnel is reduced in numbers and output is small.

When it is remembered that during the last few years it has been no uncommon thing to find shipbuilding contracts being entered into, carried forward, and completed simultaneously with the design, construction, and organization of the plants themselves, there can be no very grave reflection cast upon the ability of those entrusted with such exacting labors and responsibilities by suggesting that, in the rush of affairs, economical possibilities may not always have received the thorough attention that they deserve and even require.

The subject of shipyard economy is one which is never likely to be reduced to an exact science, but it is certain that intelligent examination and consideration of the circumstances in which, or in spite of which, economies can be effected, will enable many suggestive inferences to be drawn.

Setting aside the problems connected with design and market prices as being beyond the range of the present discussion, the practicable economies of ship construction can be roughly classified for consideration as follows:

LABOR.

1. Employment of unskilled or cheap labor upon all jobs not necessitating skilled operation.
2. Reduction of the employment of skilled labor to the minimum limit.
3. Prevention of loafing.
4. Reduction of overtime to the minimum limit.
5. Piecework rates and premium systems.
6. Abolition of timework for squaring up piecework.
7. Time rates.
8. Economy in finish.

LABOR CONTROL.

1. Proportioning the numbers and timing the operations of the various gangs so as to prevent delays.
2. Arranging the work so that the progress made by one gang or individual workman can be checked off against that made by others.
3. Under-foremen and leading hands.

ORGANIZATION.

1. Preparation and transmission of plans, lists, and other information to superintendents, foremen, and workmen.
2. Working understanding with owners' local representatives.
3. Systematic preparation and storage of fitting-out details.
4. Scope of operations of various departments.
5. Efficient supervision.
6. Standardization and specialization.

PLANT.

1. Arrangement of building and yard.
2. Use of power-driven portable tools worked by cheap labor.
3. Power station economies.
4. Transportation.
5. Arrangement of power-driven fixed tools.
6. Up-keep and new construction.
7. Shop economies.

MATERIALS.

1. Orders and deliveries.
2. Store department organization.
3. Sawmill and woodyard organization.
4. Steel and iron yard organization.

Let us now consider these items in the order given above.

LABOR.

1. *The employment of unskilled or cheap labor upon all jobs not necessitating skilled operation* is a first principle of economy which, it will be very generally admitted, requires tact and resolution to put into practice, and also keen observation and practical knowledge for the discovery of opportunities. The following are a few illustrations of cases in which this economy has been, or might be, effected, while it is safe to say that each plant has its own peculiar possibilities.

(*a*) All material prepared in the mill or shops may be transported to vessels under construction by unskilled labor, with or without the aid of mechanical transport, and in some cases may be actually put in place for fastening; yet it is no uncommon thing to find skilled workmen leaving their job on board the ship to walk to the shop, store room, or mill, wasting their own and other people's time in order to find some material they require, and finally carrying it piecemeal on their shoulders to the ship.

Under-foremen do not always realize that in such ways as this their men may often be conscientiously attending to their work while they are wasting time and money. While it is easier to arrange means of preventing waste of this sort in large plants than in small ones, it is often found advantageous to provide a "runner" for each large vessel or a convenient number of smaller ones. The "runner" is assisted by a gang of laborers, receives written notes of the material required each day by the foremen in charge on board the ships, notifies the

shop foremen, and sees that the material is brought on board as it is required. He also conveys molds and instructions from the ship to the shop as required.

(*b*) The whole of the structural ironwork of a ship can be first and second coated with paint by unskilled men, and almost 50 per cent. of finishing work done by the same labor, yet in some yards no paint is put on by any one but skilled painters.

(*c*) A great deal of work of such descriptions as laying keel blocks, launching ways, moving shores and ribbands, and even erecting uprights, getting up beams and frames, etc., is frequently done by gangs composed of shipwrights exclusively. In many cases the gangs can be made up of a mixture of skilled and unskilled men in a ratio of about 2 to 5, and will then actually turn out more work per man.

(*d*) In view of the possible combination of the mold and template systems of steel construction, which is at present the subject of a good deal of consideration, it may be remarked that while, generally speaking, those portions of the structure which require furnacing are most satisfactorily carried out by skilled workmen using their own templates, all the straight work is much simpler and could be undertaken by cheap or partially skilled labor working from molds.

2. *The reduction of the employment of skilled labor to the minimum limit* is rather more than a mere complement of the preceding section, because, apart from the fact that a skilled workman is not required to do work which can be accomplished by an unskilled man, the problem is involved of reducing as far as possible the number of operations which can only be carried out by skilled labor.

This problem is a far-reaching one, and is connected with other economical considerations which would not be appropriately discussed under a labor classification.

For example, the modern practice of employing steel and other castings for purposes formerly served by blacksmith and anglesmith work, the whole subject of the employment of power-driven and automatic tools and labor-saving devices, as well as considerations of finish and detail design, have for their object the attainment of economy in this direction, and will be touched upon later on.

3. *Prevention of loafing.* The workman who never wants to loaf may be a *rara avis*, but he is not nearly so rare as is sometimes supposed. Most men can and will work steadily if they thoroughly understand what they are expected to accomplish and if they know that there is another job ready for them as soon as the present one is completed. The "born-tired" man is easily discovered and weeded out if he is looked for. Although in some cases an under-foreman's gang may be so widely scattered that he cannot visit each individual of it more than four or five times a day, it may generally be assumed that an idle man is generally produced by an under-foreman's inefficiency or lack of sufficient instructions.

This aspect of the question, then, leads directly to the subject of *efficient supervision,* but there are several other cases which must be attributed to special causes.

When a man has passed the ticket office and the day's work is before him, it is not in average human nature to be in any particular hurry to commence. A man may wish to finish his smoke or his chat with his mate, he may not have fully digested his last meal, but, in any case, he has no great inducement to show a good example by being the first to pick up his tools. Before stopping time, again he is exposed to a strong temptation to put the tools away, get his overalls off, and be ready to make a bolt for the gate as soon as the whistle sounds.

There is only one effective check on this kind of thing, and it lies in the character and punctuality of the superintending staff. Some firms have employed a system of private policing to overcome the difficulty, but it has resulted in the suppression of appearances rather than in effective prevention. Whatever the means made use of, however, the tendency must be continually kept in check or it grows rapidly.

In very large plants, ticket offices have been erected in convenient places near the building slips, fitting-out basin, and principal shops, each man's ticket or time check being issued to him and collected as nearly as possible to his working location, to the end that the five or seven minutes which he occupies in walking from the gate to his work and vice versa do not form part of his working day. A few years ago it was not a very difficult matter in some plants for an employee to take advantage of some weak point in the time-keeping system or the ring fence to get paid for hours which he had not even spent within the works. Under the present system, by which each man's time is checked and signed for by his foreman, there is probably much less "fence-jumping" done.

A workman has often temptations to "go slow" which are in the nature of physical discomforts. He is not likely to be doing his best when subjected to extremes of heat and cold, when he is insufficiently protected from wind and weather, when he is deprived of light, space, or ventilation, or when surrounded by dirt and litter. In the workshops of our most modern plants these facts have been thoroughly recognized; in the shops equipped with mechanical heating and ventilating appliances, ample window areas, electric light, sufficient floor space, and good cleansing, more economical results are undoubtedly being attained. On board vessels partially constructed or being fitted out these desiderata are not always so thoroughly attended to, but the principle is the same, and good lighting, cleansing, and access are quite practicable. The advantages of doing all external work as far as possible during the summer months, and of having decks laid, houses built, and shells completed for the protection of men working below during the winter, where the building slips are not roofed in, are of course perfectly obvious. In concluding this section, it may be remarked that work should be done as much as possible in places where the men may easily be seen and "hole and corner" work avoided.

4. *Reduction of overtime to the minimum limit.* The reasons for working overtime are usually perfectly comprehensible, but seldom cogent. The completion of a vessel may have been unavoidably delayed, and the pressure of the owners or the financial heads of the shipbuilding firm may induce a superintendent to employ this method of hastening the completion of the work against his own better judgment. Anxiety to produce rapid construction for favorable comparison with a rival organization engaged upon similar work is another cause,

but the most plausible reason is generally the desirability of hastening certain parts of the work which may have been delayed by the non-delivery of materials or an insufficiency of machinery or other plant facilities, in order to enable the succeeding operations to be pushed on.

Overtime is not only unprofitable from the fact that increased rates of wages have to be paid for it, but the output of a workman during the last three hours of a thirteen-hour day is almost invariably reduced, and if overtime becomes a regular thing he will soon be turning out no more in thirteen hours than he previously produced in ten. Workmen who wish to increase their weekly earnings by this means are sometimes to be met with, but they usually are clever enough to avoid overtaxing their physical resources in the process.

Means for limiting the amount of overtime work naturally suggest themselves from the causes which produce it. Placing orders for materials at the earliest possible date—especially for the kinds which may occupy months in manufacture—securing well-timed deliveries, commencing construction as soon as it can be proceeded with continuously, and good progress made in the early stages will prevent unnecessary haste later on. Overtime worked for the mere purpose of racing against rival constructors can only be excused on the grounds that victory means a valuable advertisement—and the value of the advertisement is questionable—or that the enthusiasm or *esprit de corps* of the personnel is stimulated by competition. The latter idea is known to be illusory by those who have personally balanced the weariness of long hours against their fraction of glory.

When, however, it really becomes necessary or advantageous to work overtime, certain checks are of value. A morning statement from the timekeeper of all overtime worked overnight is useful to the superintendent, while better progress is made if a responsible member of the staff is known to be about while the men are at work. In some plants all overtime is forbidden except upon the superintendent's personal instructions. Night-shift work is more economical, or less wasteful, than overtime when the work in hand exceeds the daily capacity of the machine tools, and under certain circumstances it is distinctly more economical to resort to this than to sink further capital in the plant.

5. *Piecework and premium systems* have invariably been originally introduced for purposes of economy; but while doubts are now sometimes expressed as to the economy of piecework, the immediate success which was claimed for the latter system when applied to machine work does not appear to have been followed up by any attempt to adapt it to the shipbuilding trades. After a few years' trial of piecework in the iron departments, some firms have experienced a special difficulty. Improvements to the plant are seen to be desirable, alterations are made, and the men's power of production thereby increased. Certain reductions in the prices paid now appear to be perfectly reasonable, but are strongly resented by the men, and compromise is often the result. If, however, the improvements are continued under such circumstances, it soon becomes perfectly obvious that the men have been getting the lion's share of the advantages, and, unless piecework prices are controlled with unusual ability, it scarcely pays to improve the facilities of an iron shed where work is done on piece.

In some yards pieceworkers have succeeded in earning such high daily averages that the work could apparently be carried out more cheaply on time wages. Good results have been shown in machine shops from the working of a premium system grafted to an existing time wages system. Areas to be machined multiplied by suitable constants were found to give good approximations to the number of hours that the machinist would occupy on the job at time wages, and he was notified that half the hours he saved on the time so computed would be added to his week's time account.

Since contract prices may be made for piecework ironwork, the number of hours that jobs should occupy may be estimated. It does not, therefore, appear impossible to adapt the premium system for shipfitting, but the desirability of such an adaptation naturally depends upon various circumstances and local conditions.

Without entering fully into the subject of premium systems, it may be said that they have already shown economical results, and may be the means of effecting some of the shipyard economies of the future. The following suggest themselves as possible fields for the introduction of this system.

(*a*) Shop joiner work.

(*b*) Fitting up state rooms and store rooms in merchant vesels.

(*c*) Fitting up shell rooms, magazines, and store rooms in warships, as well as:

(*d*) Shipfitting.

(*e*) Anglesmith work.

(*f*) Blacksmith work.

6. *Abolition of timework for squaring up piecework* may be dismissed with little more than a reference, for, although in a few plants abuses have arisen in busy times from the fact that pieceworkers will generally take every advantage they can in the matter of leaving their work incomplete, in dull times like the present, proper completion can easily be insisted upon.

7. *Time rates* of wages in this country are admittedly much in excess of those ruling in Europe, and, in some cases, outside demand has resulted in curious inequalities between the maximum rates paid to skilled men in different trades. While wages cannot be expected to come down to the European level, what possibilities there are of making reductions must of course be taken advantage of in dull times or not at all. From the employer's point of view it is, no doubt, good policy to encourage as many young men as possible to enter the various trades for the purpose of qualifying as skilled operatives.

8. *Economy in finish* is well understood in America, and can be attained without any detriment to the essentials, not only by avoiding hand labor wherever machine work will serve the purpose, but also by employing the cheapest materials which are suitable and satisfactory; and these considerations are as important in vessels requiring the highest finish as in the cheaper types of ships.

Modern wood-working machinery will now produce work so nearly complete that little more than the glueing up has to be done by hand, but care requires to be taken that, in designing and arranging the details of the

joiner work, the range of operations which the existing machinery is capable of is utilized to the fullest extent.

This economy in finish which depends upon detail design is also to be looked for in work produced by other departments, and much more ingenuity is shown by some shipyards in this respect than by others.

The following directions were posted in one drawing room and are of interest in this connection:

Don't use composition where cast steel or wrought iron will serve.

Don't use cast steel or wrought iron where cast iron will serve.

Don't draw out a new pattern if an old one will serve.

Don't order hand forgings if you can use drop forgings.

Don't finish anything that can be left rough.

Don't finish anything by hand that can be arranged for machining.

Don't forget lubrication and save weight.

The following are a few examples of economies which are not by any means general yet:

The use of the emery wheel for cleaning up forgings and castings where the chisel and file were formerly used.

The use of the buff wheel for polishing stanchions and other brasswork, to the exclusion of lathe work and hand filing.

Use of malleable cast iron and spelter collars for bulb beams passing through steel superstructure deck houses.

Extended use of special products, such as hydraulically embossed papier maché, wood, leather, etc., to replace hand-carved work for interior decoration.

LABOR CONTROL.

1. *Proportioning the numbers and timing the operations of the various gangs of men so as to prevent delays* is a most important matter in shipbuilding, since the progress of so much of the work depends entirely upon the completion of what has gone before, and both foresight and experience are required for success. When, however, a firm is doing work of a more or less settled type, the records of a previous vessel will provide very useful information for a succeeding one if properly kept. The essential points are that the daily returns of the timekeeper must be properly classified in the labor records for each vessel, and that progress records must be kept in connection with the labor records.

As an example of one method by which this may be effected, the machinist labor on a battleship was daily reported under the following sections:

(*a*) Pumping, flooding, drainage, and ventilation.

(*b*) Turret, casemate, gun, and ammunition hoist fittings.

(*c*) Water-tight and air-tight doors, shutters, and manholes, and gearing up to main deck.

(*d*) Hatchways, shutters, skylights, etc., above main deck, and general shipfittings.

(*e*) Shopwork.

As each of these sections, except the last, was looked after by a separate foreman, each was provided with a properly drawn up summary of his work, arranged so that dates could be written in for the commencement and completion of each item. Percentage records could thus be easily obtained each week of all progress made, for comparison with the labor expended to date.

2. *Arranging the work so that progress made by one gang or individual workman can be checked off against that made by others* gives the men the incentive of competition, and can often be easily arranged for by a little foresight. Laying wood decks and hold ceilings, finishing state rooms, water testing compartments, fitting water-tight and other doors, shutters, and hatches, and fitting launching ways and packing, are some examples of work which may be thus arranged.

3. *Under foremen and leading men* carry out work which may not be a very heavy tax upon their intelligence, but since successful shipbuilding largely depends upon the efficient control by these men of the operatives, they must not only be carefully selected, but kept thoroughly informed by plans, lists, and daily notes. It is neither possible nor desirable to give an under foreman complete schedules and information regarding his work on a ship at the outset, but it is absolutely necessary to keep him posted well in advance and have the materials ready for him as he requires them. He can always be given a completion date to work to, and the combined labor and progress records before alluded to quickly show if progress is unsatisfactory.

Leading men are always used, officially or unofficially, by under-foremen who have charge of upward of 30 men. Official recognition of this by a slight advance in wages establishes a system by means of which men are put into training to become under-foremen, and which provides retiring positions for under-foremen in dull times.

(To be continued.)

Paper for Printing Blue Lines on White Ground.

The following process, credited to Captain Abney, yields a photographic paper giving blue lines on a white ground:

Common salt	3 ounces
Ferric chloride	8 ounces
Tartaric acid	3 1-4 ounces
Acacia	25 ounces
Water	100 ounces

Dissolve the acacia in half the water, and dissolve the other ingredients in the other half; then mix.

The liquid is applied with a brush to strongly-sized and well-rolled paper in a subdued light. The coating should be as even as possible. The paper should be dried rapidly to prevent the solution sinking into its pores. When dry, the paper is ready for exposure.

In sunlight one or two minutes are generally sufficient to give an image, while in a dull light as much as an hour is necessary.

To develop the print, it is floated, immediately after leaving the printing frame, upon a saturated solution of potassium ferrocyanide. None of the developing solution should be allowed to reach the back. The development is usually complete in less than a minute. The paper may be lifted off the solution when the face is wetted, the development proceeding with that which adheres to the print. A blue coloration of the background shows insufficient exposure; and pale blue, over-exposure.

When the development is complete, the print is floated on clean water, and after two or three minutes is placed in a bath made as follows:

Sulphuric acid	3 ounces
Hydrochloric acid	8 ounces
Water	100 ounces

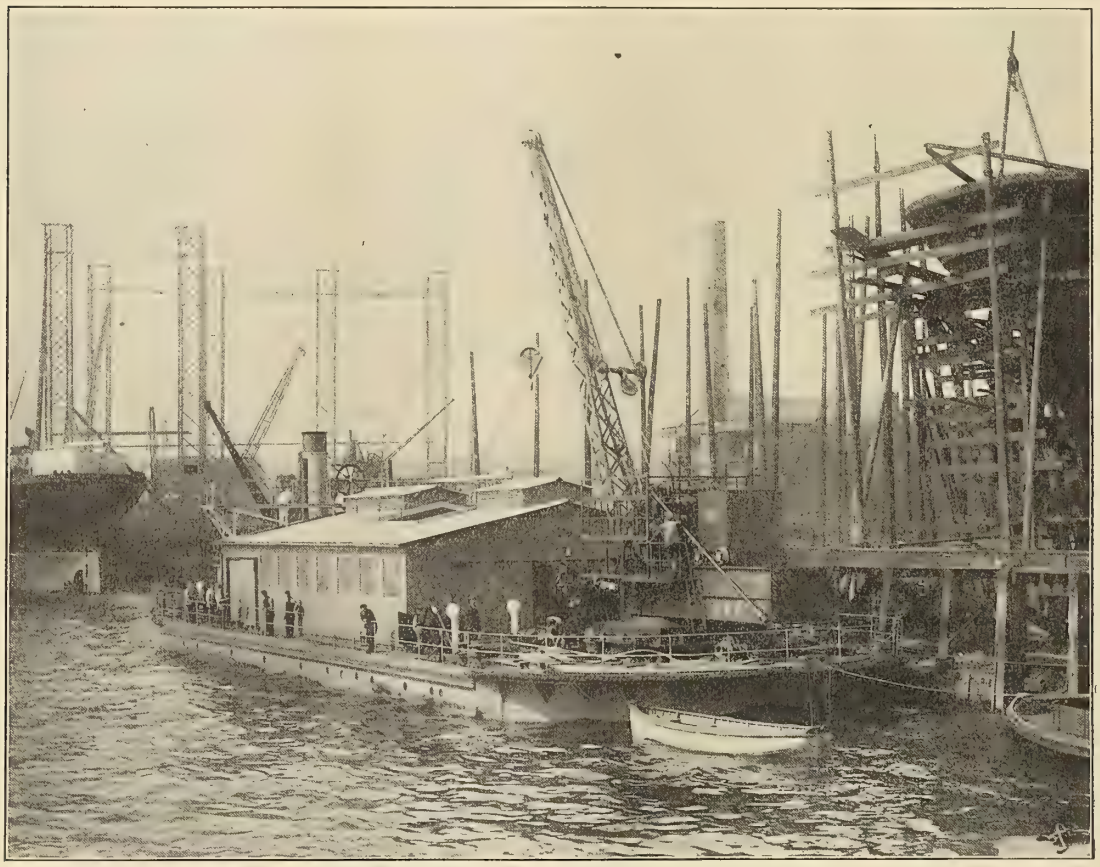
In about ten minutes the acid will have removed all iron salts not turned into the blue compound. It is next thoroughly washed and dried. Blue spots may be removed by a 4 per cent. solution of caustic potash.

The back of the tracing must be placed in contact with the sensitive surface.—*Drug. Circ. and Chem. Gaz.*

A Floating Workshop.

In an English shipyard there has recently been completed a floating workshop for use in Durban harbor, South Africa. The vessel is expected to be used chiefly in repairs to steamers as they lie at anchor or in dock, for the craft can proceed directly to the vessel.

The workshop was built at the yard of Swan and Hunter, the builders of the Durban floating dry-dock, and was docked by the latter, and both will be towed to their destination at Durban. The workshop float is 129 feet 3 inches long, 40 feet wide inside of fenders, and 8 feet 4 inches molded depth. Although, as seen in the illustration, the ends are very bluff, yet on her trial trip a speed of 7.12 knots was obtained. The craft is propelled by two screws, each driven by a compound condensing engine with cylinders 12 and 26 inches by 15 inches stroke. A Scotch boiler supplies steam at 130 pounds pressure. The workshop is erected on the deck and contains the following tools: A screw-cutting gap lathe, 10 inches centers and 15 feet bed, admitting 9 feet 6 inches between centers and 3 feet 4 inches by 12 inches in the gap; a shaping machine with a maximum drilling and tapping machine, and a 5-foot radial drilling machine; a 3-cwt. steam hammer on a special foundation, and a punching and shearing machine which will punch 1-inch holes in 1-inch steel plate and shear plates of the same thickness, angles, etc. There are also two fixed smith fires and a portable fire, and a slab for leveling. A 3-inch pipe-screwing machine is also found in this commodious workshop. The tools are driven electrically by motors; a reserve of 10 horse power has been provided for additional tools that may be added from time to time. The vessel is lighted electrically from the same generating plant, which consists of a 6-pole dynamo giving 300 amperes at 110 volts at a speed of 320, cylinders 8 1-2 and 14 1-2 by 9 inches stroke. There are six motors, one to each machine, only the fan and grindstone being belt-driven.



FLOATING WORKSHOP FOR SOUTH AFRICAN HARBOR.

On the forward deck is a 40-ton cantilever crane with 40-foot span, which is expected to be of service in harbor work as well as in ship-repair work. The ship is well lighted by large windows at the sides, and ventilation is secured through the roof, which is also fitted with a large hatch. There are also accommodations for six Europeans and ten natives.

In the hold is abundant space for supplies of all kinds, and in the bunkers on either side of the boiler 38 tons of coal can be stored. The fresh-water tanks hold about 20 tons.

INTERNAL-COMBUSTION MOTORS FOR CANAL-BOAT TRACTION.*

BY JULIUS KUSTER.

There seems to be promise of a wide field of usefulness for the internal-combustion motor in the propulsion of motor canal boats. Of first importance in this respect is the economy which the new types of motor offer in comparison with that of the steam engine, and which in this respect seems to give the combustion motor an important point of relative advantage.

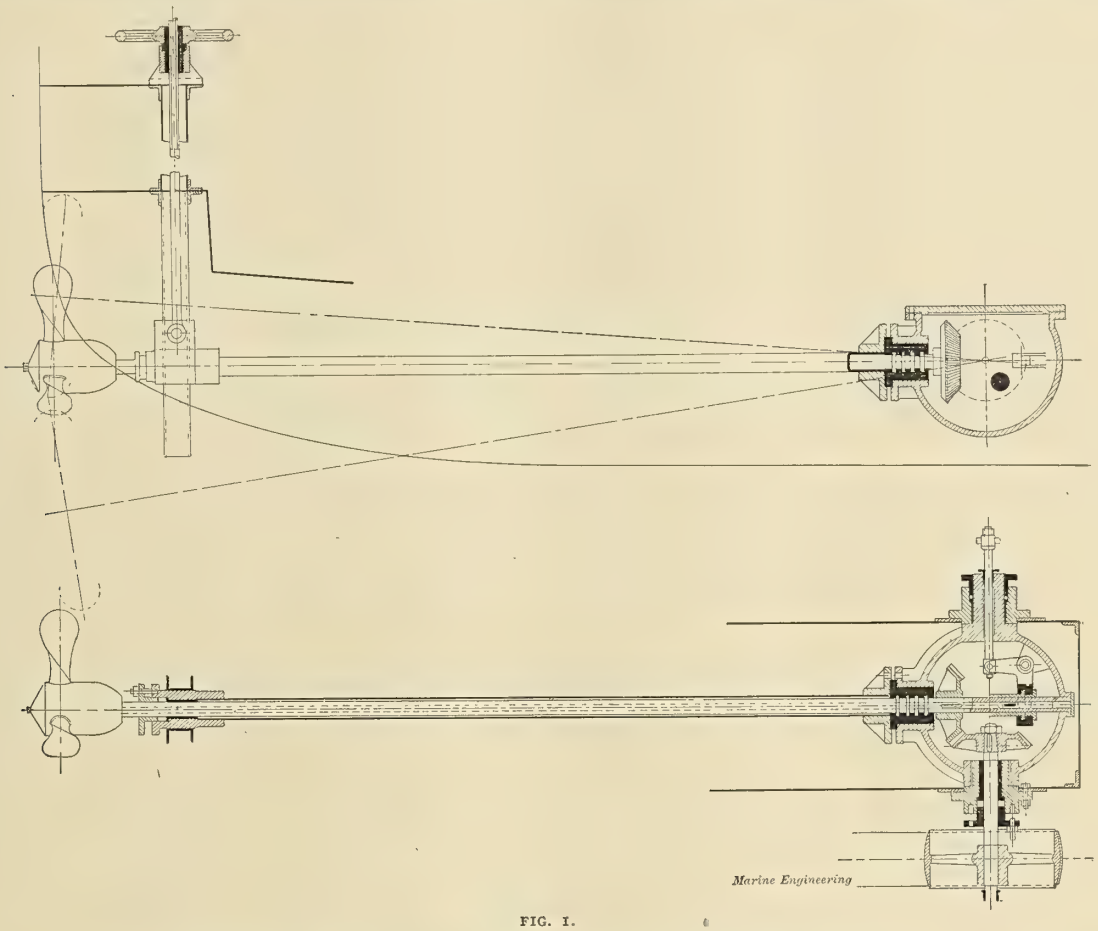


FIG. 1.

Before we proceed, however, with the development of the Deutzer boat motor in relation to its application to canal-boat propulsion, it may be of interest to glance briefly over the various methods which have hitherto been attempted for the mechanical propulsion of canal boats.

More than twenty years ago there existed a commercial demand for some type of steam canal boat, but at the time such craft had not become in any manner definitely adapted to such special purpose. It was found that the weight of the steam boiler and engine, under the conditions existing, reduced seriously the available capacity for cargo, and also that much damage resulted to the banks of the canal from the waves developed by the propulsion of the boats at the speeds attempted. In the commercial waterways between Magdeburg, Berlin, and Stettin are still to be found a limited number of fast steam canal boats, although this type of carrier has lost clearly 20 per cent. of cargo capacity by reason of the necessary equipment of machinery and boilers. In order to make good this loss the attempt was soon made to transfer the motive power to the land, as in the case of horse traction so long used, and thus there were introduced at an early date steam locomotives which towed the boats by a suitable arrangement of cable. However, on the Oder-Spree canal, as also in France, it has been found that this form of traction cannot successfully rival that by horses.

Also the centralization of the mechanical installation in connection with a single towline for several canal boats gave rise to serious difficulty in connection with the necessary management of the lines.

It is natural, in the early years of the development of electricity, that this source should have been thought of as a means of propulsion for canal boats. The first efforts also naturally took the form of electric trolley lines along the banks of the canal, since storage batteries soon demonstrated their lack of adaptation to the demands of such service. The use of such lines along the canal called again for a choice between the installation of electric motors on the boat or on a truck running on tracks along the towpath of the canal. The results of the development of this system were, however, far from satisfactory. As the principal objection

*Translated for MARINE ENGINEERING from *Zeitschrift des Mitteleuropaischen Motorwagen-Vereins.*

it was recognized that the boat remained constantly dependent on a central source of power, and that every disturbance in the supply of power exercised a serious influence on the cost of operation. In consequence it was found necessary to have constantly ready for use a towing machine, and the frequency of demand in a canal which does a large business is exceedingly variable. It was found also that the towline passing from the boat to the bank, especially in the night and in connection with the meeting and passing of deeply-laden boats, was found to be the source of serious hindrance and trouble. Furthermore, an electric towing locomotive adequate for such demands could only be made to pay on a canal with a volume of traffic not less than one million tons yearly, and this figure is but rarely reached, and in addition it was found that no urging could induce the boatmen to utilize their horses as well.

So in the end, as the use of both steam boiler and steam engine, either on the boats themselves or by any form of distribution from a central station, seemed to prove unsuitable, attention became concentrated on the internal-combustion motor. As this type seems adequate for all demands, as it requires no specially equipped engineer for its care, as it takes but little from the carrying capacity of the boat, so must the cost of operation through the installation of such type of motors become materially reduced.

Attention must also be paid to a further consideration: the protection of the canal bed and banks from injury by washing. These latter conditions the Deutzer Gas Motor Company have met by the use of a propeller carried on a shaft which may be elevated or depressed, according as the conditions may demand. This is shown in Fig. 1 in vertical and horizontal plans and in part in section, and was first fitted in 1899. The same arrangement is now fitted with a reversing or adjustable blade propeller.

In order to make possible the elevation and depression of the propeller with the stern tube, the latter is made capable of rotation about a horizontal transverse shaft. About the latter is a spherical casing containing a bearing for the drive shaft, which gears to the forward end of the propeller shaft through a pair of bevel gears. This casing also carries in its central line on the opposite side the necessary connections for controlling and setting the adjustable blades of the propeller. To the outer end of the transverse shaft is attached a belt wheel. Attached to the casing on the after side is also the propeller-shaft stuffing box. The gear wheels and bearings can be kept flooded with oil by reason of the water-tight construction of the casing. At the after end of the shaft casing the stuffing box is carried in a vertical guide, and through suitable connections it may be elevated or lowered, even when the machinery is in operation.

The chief purpose of this adjustable screw shaft is to provide for a continuously uniform immersion of the propeller, whether the boat is deep or only light laden. In the case of the canal boats, as shown in Fig. 2, one propeller is provided with vertical adjustment, while two at the side are installed with fixed location, and both of the two latter, or the middle propeller alone, may by suitable belt connections be operated by one and the same combustion motor. The operation of the middle propeller follows naturally through the above-described gear casing and connections. In the case of a light boat the middle propeller is adjusted in its lowest position, as shown, while the two side propellers in such case will scarcely touch the water. In the case of deep load the middle propeller is raised to its highest adjustment, while the two side propellers, now fully immersed, are connected with the motor and serve to propel the boat. The motor is of 16 H. P., and with this power in free water a speed of a little over two miles per hour with 270 tons load has been attained.

In order to bring about greater simplification a later boat was fitted with but one central adjustable propeller. This adjustable propeller operates as well under light condition as under full load. In this case, furthermore, the propeller was of three blades, in order that the blades might be made reversible for backing and going ahead without reversing the motor.

The second point of importance, as noted above, regarding the propulsion of canal boats with combustion motors rather than with steam power, relates to the practicability of a producer gas installation. Such means for the development of power are not readily applicable to the demands of the automobile, and can scarcely expect to receive serious attention from those chiefly concerned with this particular field for combustion motors. This is not the case, however, for boat propulsion, and its possible applications in this direction merit therefore careful attention.

The methods which have been mostly in use for the past fifteen years for the generation of "producer" gas have involved the passage of a blast of steam and air through glowing coal. With such an equipment a steam boiler and holder for the gas was requisite. These demand careful supervision, and the space required is also very considerable. Through a great simplification in the methods of operation, however, the possibilities of this gas have recently received a new significance. Both boiler and special gas holder may be dispensed with, and the action of the piston within the cylinder on the entering stroke is found sufficient to form the vacuum in the pipes leading to the cylinder necessary to draw through glowing coal a charge of air laden with vapor, which thus automatically enters and fills the cylinder. The generator, which consists of a small roasting oven, contains in its upper part a water shell which is heated by the action of the gases themselves. The entering air thus becomes saturated with water vapor over the surface of this water, and is thus brought into the condition necessary for the formation of gas. Then by passage through a layer of glowing coal the gas becomes charged with carbon monoxide, thus providing the chief combustible component. Then, before admission to the motor, the gas is cooled and cleaned by passage through a water spray, thus clearing it of any dust or tar which it may contain. The gas, after being generated, is collected in a holder in the top, thus providing a reserve supply and a more uniform flow to the engine.

The feeding of the gas generator with coal is provided by a hopper placed conveniently over the oven, and the proportions are such that one filling of the hopper suffices for a considerable length of time.

In starting up the apparatus the necessary air blast must naturally be supplied by a hand-blowing device.

During this period the smoke and gases are led away through a funnel provided for the purpose.

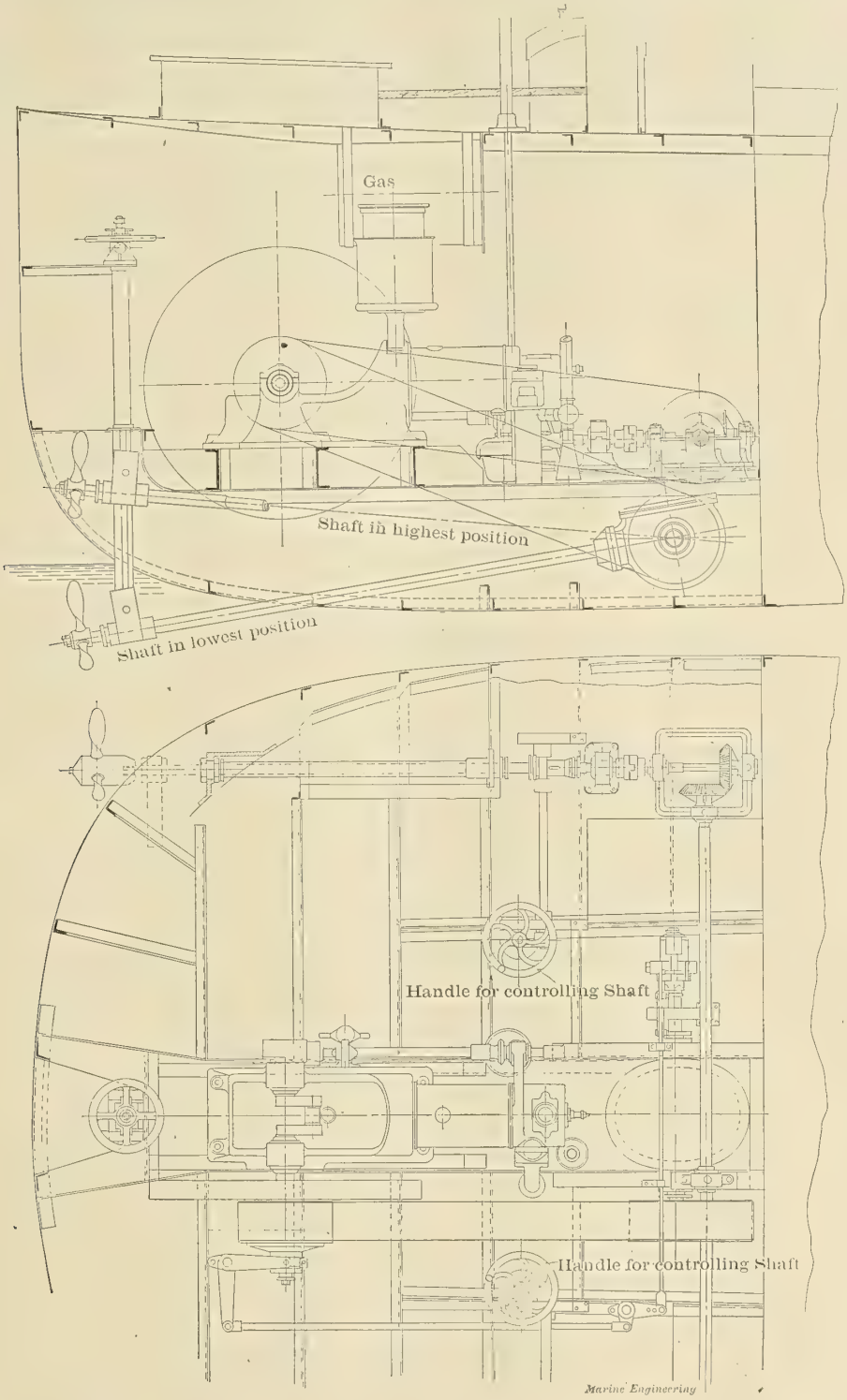


FIG. 2.

In the form of producer gas apparatus installed in the canal boat *Haldy I.*, mentioned above, the generator and gas holder stand at the side of the machinery space and the motor itself in the middle. The furnace is filled with coal through a suitably-fitted chute leading from the deck above. The only remaining attention required is the occasional cleaning of the grate from ash and cinders.

The above-described type of installation for making producer gas is not, however, well adapted to small or

fine-formed boats. In such cases a somewhat different construction is preferable, especially as in such cases the available room at the stern may not be more than sufficient for the installation of the propeller. The carrying capacity of such boats will of course be reduced by especial fineness of form at the stern, but, nevertheless, such form is to be preferred by reason of the smaller stern wave which is produced by the passage of the boat through the water.

A third type of this producer gas apparatus is made suitable for use on river boats and where the installation of propeller shaft is of the usual character instead of adjustable, as in the cases above noted. The motor here illustrated is of the two-cylinder, balanced type, high speed, and of 40 horse power.

The especial advantage of the producer gas installation for river and canal boats consists primarily in the decrease of the cost of operation as compared with combustion motors using benzine, petroleum, or wood alcohol. In Holland the two latter can be obtained in quantity, since there is no impost; but in Germany and France the expense of such mode of operation would be prohibitive. If we take, for example, an ordinary type of river steamer of, say, 275 tons, and with a speed of about two miles per hour, requiring seven to eight horse power per mile hour, then in Germany or France the cost of such a mode of propulsion with spirit or gasoline would reach from 16 to 20 cents per mile hour. Adding to this the necessary fixed charges and there would remain very slight advantage in comparison with the use of horses. With producer gas, and an installation similar to those above described, these figures would fall to from 2.5 to 3.7 cents. Including fixed charges, in the case of the canal boat *Haldy I.*, mentioned above, the cost per mile is from 6 to 7.5 cents, or from 2.5 to 3 cents per ton mile. While with such small power the operation expenses with a steam boiler and engine outfit would be not less than the higher figures quoted above, such is not the case with the producer gas outfit, and on account of its great simplicity and adaptation to the requirements of the situation, it would appear to have solid points of advantage for service of this character.

Data Cards.

The following cards are made up from data found in two papers read at the recent annual meeting of the Society of Naval Architects and Marine Engineers. The *Noma* was described in a paper presented by Mr. Clinton H. Crane, and the *Minnesota* in another paper by Mr. Charles R. Hanscom. Both of these papers were accompanied by drawings of the vessels.

NAME—Noma.	NATIONALITY—American.	TYPE—Steam yacht.
LAUNCHED—1903.	DESIGNER—Tams, Lemoine and Crane.	BUILDER—Burlee Dry Dock Co.

Length over all	252 ft. 0 ins.
" load water line	226 " 0 "
Beam	28 " 5 "
Depth	18 " 3 1-4 "
Draft, aft	14 " 0 "
" forward	12 " 0 "
Displacement on trial	1,035 tons
Prismatic coefficient	.601
Speed on trial	19.06 knots
Bunker capacity	230 tons
Coal on trial	150 "
Fresh-water capacity	12,500 gals.
Engine—4-cylinder, triple-expansion	
Cylinder diams.—17, 27, 32, and 32 ins.	
Stroke	24 "
Revolutions, trial	205
I. H. P., "	4,200
Propellers	2, three-bladed
Diameter	9 ft. 0 ins.
Pitch	11 " 0 "
Boilers: Number	6
Type	Almy water tube
H. S.	9,995 sq. ft.
G. S.	221 " "
Area of boiler floor space	600 " "
Forced draft, closed stokehold, air pressure	2 1-2 ins.
Blowers, number	3
Diameter	54 ins.
Revolutions	500
Width at tips	20 ins.
H. S. ÷ G. S.	45.
H. S. ÷ I. H. P.	2.36
I. H. P. ÷ G. S.	19.0

NAME—Minnesota.	NATIONALITY—American.	TYPE—Ocean passenger and freight.
LAUNCHED—1903.	BUILDER—Eastern Shipbuilding Co.	OWNER—Great Northern Steamship Company.

Length over all	630 ft. 0 ins.
" between perps	608 " 0 "
Beam, extreme	73 " 6 "
Depth, from bottom of keel to upper navigating bridge	88 " 3 3-4 "
Depth, from bottom of keel to upper deck center	56 " 1 in.
Water ballast, total	5,072 tons
Coal bunker, total capacity	6,156 "
Dead-weight cargo capacity, excluding reserve coal bunker	30,000 "
Total stores	250 "
Draft, load	33 ft.
Corresponding displacement	33,000 tons
Block coef.	.761
Prismatic coef.	.8
Launching draft, aft	14 ft. 10 ins.
" " forward	10 " 6 "
" weight	about 11,000 tons
Ground ways, distance bet. centers	25 ft. 6 ins.
Length over all	810 " 0 "
" beyond stern post	235 " 9 "
Width	5 " 4 "
" where fore poppet presses	6 " 0 "
Declivity per foot	.636 inch
Sliding ways, length	550 ft. 9 ins
Width	4 " 6 "
Area	4,960 sq. ft.
Declivity of keel per foot	.54 in.
Pressure per square foot of fore poppet	13 tons
Water over end of ways	10 ft. 11 ins.

Manufacture of Seamless Cold-Drawn Steel Boiler Tubes.

BY G. M. KOHLER, ASST. ENGINEER, U.S.R.C.S.

Very few sea-going engineers have ever had the opportunity of witnessing the manufacture of seamless boiler tubes. It is for the benefit of those who have never had this opportunity that this article is written.

A seamless tube is one that is made from a solid piece of steel, or "billet," as it is called. These billets are open-hearth basic steel and show approximately the following analysis: carbon, .17 per cent.; manganese, .45 per cent.; sulphur, .025 per cent.; phosphorus, .10 per cent. Steel having more than .18 per cent. carbon is not used.

The material is received from the steel mills in solid pieces about ten feet long and four or five inches in diameter. The first step in the manufacture of the tube is to cut these long bars into smaller pieces of such length as to contain enough metal to make one tube of the required size. A piece about 18 inches long and 5 inches diameter will make a 3 1-2-inch tube about 14 feet long. These small pieces or billets are cut from the long bars, either hot or cold, by means of saws.

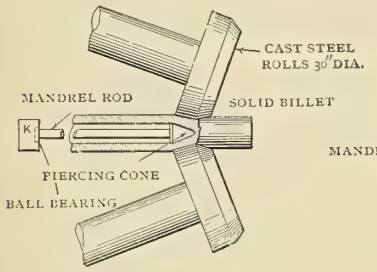


FIG. 1

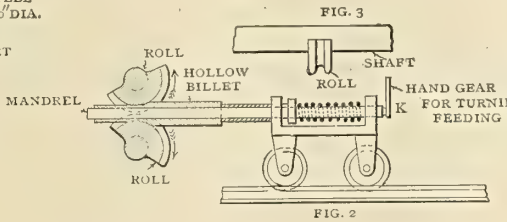


FIG. 2

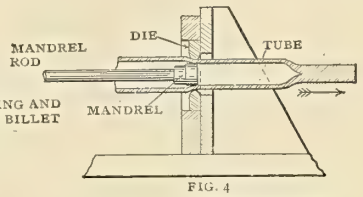


FIG. 4
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It requires about sixteen minutes to cut a 5-inch diameter bar when cold and a much shorter time if the bar be heated to a cherry red. These saws are of the best steel suited for the purpose, and one saw will run about 18 hours without being sharpened. Some mills cut the billet from the bar by the use of a steam hammer and knife; this method, while being very quick and cheap, leaves the end of the billet rough and ragged, causing the end of the tube after drawing to be of poor quality and unfit for use.

After the billets are cut they are taken to a drill press, where a 1-inch hole is drilled in the center of one end to a depth of about one-half inch. This hole is for the purpose of centering the piercing cone in the piercing mill.

PIERCING THE BILLETS.

The most interesting part in the manufacture of the tubes is the piercing of the solid billets. After they are centered in the drill press they are placed in a gas furnace made of fire brick and rectangular in shape. The fuel used is gas obtained from the distillation of bituminous coal. These furnaces are so arranged that the billets enter the coolest part and gradually roll to the hottest part. This is for the purpose of slowly heating the billet so as to have it of the same temperature throughout. It requires about three hours for the billet to pass through the furnace, at the end of which time it is at a bright-yellow heat and is ready for the piercing mill.

This mill pierces a hole through the billet longitudinally, and at the same time increases its length about 100 per cent. As shown in Fig. 1, the piercing mill consists of two large cast-steel disks, about 30 inches in diameter and 16 inches thick, which revolve at about 100 revolutions per minute. The piercing cone fits loosely on a mandrel which is free to turn and is fitted in a ball-bearing socket at the end *K*. This bearing takes up the thrust due to the disks forcing the solid billet over the piercing cone. The thrust is very large, and if it were not for the ball bearing the mandrel and piercing cone would not revolve, as they would be held from doing so by the friction at the end of the rod.

When the billet is taken from the furnace at a yellow heat it is placed in a guide, such that it enters between the disks, as shown, in the same plane as the axis of the shafts which revolve the disks; the piercing cone then enters the center of the billet and in the small hole which was drilled for this purpose. As soon as the billet comes in contact with the revolving disks it is given their circular motion and at the same time thrust forward by them over the piercing cone. This thrust is of the same nature as that which causes a belt to climb to the highest part of a revolving pulley. After each billet is pierced the cone and mandrel are thrown into cold water and allowed to cool; a stream of water is also turned on the disks for the same purpose.

ROLLING THE HOLLOW BILLETS.

The billet, which is now known as a hollow billet, and is still at a good yellow heat, is now ready to be rolled to reduce the thickness of the walls and at the same time to increase its length. The rolling is carried out to such an extent that the tube is about 1-2 inch larger in diameter and about five gauges B. W. G. thicker than the finished tube. There are two different methods of rolling. Some mills use the ordinary cast-iron rolls, the tube being placed on a mandrel whose point is held between the rolls. The tube is given about six to eight passes through the rolls, care being taken that it is turned through 90 degrees after each pass, so that the walls may be rolled of even thickness throughout its entire length.

A somewhat different method of rolling is roughly illustrated by Fig. 2, from which it is seen that there are two semi-circular rolls, each forged on a shaft. These rolls are about 24 inches in diameter, and are grooved as shown in Fig. 3. The hollow billet, as soon as it comes from the piercing mill, is placed on a mandrel,

the end of which is then inserted into a socket and carried on a truck. The truck is then pushed forward until the end of the mandrel and billet comes between the rolls. The rolls revolve in the direction shown by the arrows, which tends to thrust the billet out from under the rolls. To overcome this the socket in which the mandrel is secured is fitted with helical springs, which are compressed when the rolls push the billet out. As soon as the rolls leave the billet the energy which is stored in the springs pushes it back, so that by the time the rolls come around again the billet is back in its proper position under the rolls. As the billet is rolled out it must be fed under the rolls, and also turned on its axis to prevent uneven rolling. For both of these purposes there is a suitable hand gear located as shown.

The tube is now about six to eight times the length of the original billet. The inside of the tube is smooth and free from scale, but the outside has considerable scale on it. The tubes are allowed to cool in the open air, after which one end is heated in a gas furnace, then taken out and pointed under a small steam hammer: this point is about one foot long and serves as gripping surface for the pliers on the cold-drawing benches. To remove the scale the tubes are sent to the pickling room and immersed in a solution of sulphuric acid. After the scale has been loosened up the tubes are rinsed off with water, then placed in another tank containing a mixture of tallow, flour, and warm water. This operation is called "doping." They are left in the doping tank for about one-half hour; then they are dried and are ready for the first pass on the cold-drawing bench.

COLD DRAWING.

Fig. 4 illustrates the principle involved, from which it is seen that one end of the tube is open and the other closed or pointed. As stated above, this point is for the purpose of gripping the tube by the pliers which pull it through the die. The mandrel is carried on the end of a long rod, the end of which is fastened to the end of the draw bench. After the mandrel is placed in the tube the pointed end of the tube is passed through the die and the drawing pliers made to grip it. By a suitable connection with an endless chain, the pliers draw the tube slowly through the die (about nine to twelve feet per minute). As the tube passes through the die it is reduced in thickness and diameter and also lengthened about 20 per cent.

The cold drawing of the tube causes the metal to become brittle, so that after each pass it is found necessary to anneal and dope them. To anneal them they are heated to a cherry red in an oven, then allowed to gradually cool in the open air. They are then doped again and given another pass at the cold-drawing benches.

The number of cold passes given to the tube depends upon, first, the strength of the mandrel rod; second, the strength of the material in the tube; third, the thickness of the walls of the tube. From Fig. 4 it is clear that, in drawing, the pliers tend to pull the tube apart at the die; also, the mandrel rod tends to come through the die, due to the friction between the metal of the tube and the mandrel; hence the pull of the pliers must not equal the tensile strength of the tube or the mandrel rod. It usually requires about three passes on the cold drawing bench, though for tubes with thin walls twice this number of passes may be necessary.

After the tubes are finished in the bench room the pointed end is cut off in a lathe and this end of the tube gauged for thickness. If the walls are of the proper thickness and concentric, the tube is cut to length and gauged at the end last cut off.

The surface of the tube as it comes from the cold-drawing benches is very smooth, almost polished, but the metal, as stated above, is hard and brittle, requiring a final annealing. This is carried out in closed sheet-iron retorts, about 14 inches in diameter and about 25 feet long, with the ends fitted with cast-iron headers. The tubes are placed in the retorts, the ends closed, and the retort then pulled into a long, rectangular furnace. About every twenty minutes the retort is turned around 90 degrees by rolling it toward the other end of the furnace; finally, about two or three hours after it first entered, when the tubes are at a cherry-red heat, the retort reaches the other end of the furnace and is taken out and allowed to cool for about 12 hours. The tubes are then removed from the retort.

The tubes after being annealed are very crooked and need to be straightened. This is done by supporting the tube, with curved part upward, on two grooved rollers about five feet apart; between these rollers is a die working vertically, which, as it descends, forces the curved part of the tube downward; the tube is moved along the rollers, and, by repeated operations of the die, is made perfectly straight.

Record Long-Distance Run.—The steamship *Texan,* of the American-Hawaiian Steamship Company, arrived at Philadelphia from the Pacific on November 17. She left Tacoma on September 21 and steamed 14,100 miles without coaling or entering a port, the first voyage of this kind ever sailed. The *Texan* was in charge of Captain D. D. Morrison, and John L. MacVicar was chief engineer. Passing through the Straits of Magellan two stops were made to wait for daylight, but these were the only ones on the entire voyage.

Steamship Manchuria.—The steamship *Manchuria,* which stuck on the ways on October 31, was finally launched on November 2 from the yard of the New York Shipbuilding Company, Camden, N. J. The *Manchuria* is a sister ship to the *Mongolia,* launched from the same yard on July 25, and is for the transpacific service of the Pacific Mail Steamship Company. These two ships were originally ordered by the Atlantic Transport Line, but were later sold to the present owners. Each is 600 feet between perpendiculars, 65 feet beam, and 51 feet depth, the displacement being 26,530 tons, and the dead-weight carrying capacity 14,000 tons. The vessels have four complete steel decks and a bridge house amidships. The rig is that of a four-masted schooner with one smokestack. Special arrangements have been made for the rapid handling of cargoes. Accommodations are provided for 350 first-class passengers, 68 second-class, 1,300 steerage, and a crew of 216. Twin-screw, triple-expansion engines are installed, with a designed horse power of 12,000, which should give the ship a speed of 16 knots. Steam is supplied by four double-end and four single-end Scotch boilers.

NOTES ON THE ARRANGEMENT AND CONSTRUCTION OF STEAM PIPES AND THEIR CONNECTIONS.*

BY ROBERT C. MONTEAGLE.

The principal object of this paper is, first, to point out and emphasize some of the causes of failure of steam pipes, and, second, to describe some points in the general design, as well as material entering into the construction of steam pipes, which go far to insure their integrity under the most severe conditions of service. The subject is one which is becoming more important every year, owing to the rapidly increasing steam pressures which are coming into such general use. The causes of failure in steam pipes may be classified as follows: first, faulty design; second, bad workmanship; and, third, defective material. The first of these, viz., faulty design in some one of its many and varied forms, is in evidence in a remarkably large percentage of vessels. One of these forms of faulty design is in the employment of copper for pressures exceeding, say, 150 pounds per square inch. Owing to the number of accidents occurring with copper steam pipes, this material is being used less frequently in each succeeding year. The elastic limit of good sheet copper is reached at from 5,300 to 5,600 pounds per square inch, and the ultimate tensile strength about 30,000 pounds per square inch In good steel pipe the elastic limit reaches from 30,000 to 35,000 pounds per square inch, and the tensile strength 53,000 to 60,000 pounds per square inch. These figures alone demonstrate the hopeless inferiority of copper for use in steam pipes as against steel. It may be accepted as a fact, also, that copper in the vicinity of brazing is more or less injured by the heating, and in some cases by the overheating, which they are subjected to; yet where copper steam pipes, say six inches in diameter and over, are used, the best practice is to "make them up." My reasons for so stating are that solid-drawn copper piping of such diameter and the necessary thickness required is almost invariably of a non-uniform thickness, and frequently possesses the undesirable characteristic or tendency to split longitudinally.

This characteristic, it may be noted, seldom develops at the original time of testing, and hence its extreme danger. On the other hand, brazed copper piping never can possess the same strength as the original sheet from which it was made, even granting that the workmanship is exceptionally good. Rules are given for determining the thickness of copper to be used in steam pipes, in the pamphlet issued by the Board of Supervising Inspectors of Steam Vessels, but which do not state that such thickness should be increased where bends occur. Almost any engineer is familiar with this requirement, but unfortunately there are individuals who deem it good practice to elude their duty when presented in this or other similar form. It is, therefore, important that this requirement be embodied in the said rules. A better rule would be to *prohibit the use of copper* for steam pipes which are subjected to pressures exceeding, say, 150 pounds per square inch, and which exceed, say, 3 inches in diameter. A glaring error which has been perpetuated from one edition to another in this pamphlet is where this phrase occurs: "The flanges of all copper steam pipes over 3 inches in diameter shall be made of *bronze or brass composition,* shall be securely brazed to pipe," etc. This of course should read "brazing metal." Another form of faulty design is frequently found in the method of allowance for expansion. The two ordinary methods are illustrated in Fig. 1 and Fig. 4. The method at Fig. 1 has the drawback of being unbalanced, and therefore must be furnished with "preventer bolts" so that the sleeve may not be forced out of place by the unbalanced pressure. The adjustment of these bolts must be accurately made, or an undue strain will be brought on the piping, either when steam is turned on or when the piping is cold. The other method, at Fig. 4, is a simple dependence on the flexibility of the piping itself to take up the expansion. With piping, say, 3 inches in diameter and over, this is not good practice, as the metal will become crystalized after constant working, and is liable to crack or break at the most rigid point. This class of accidents has in various cases been fatal.

Another form of faulty design, and a common one, is in the formation of depressions, however slight, in the piping, or, in other words, dropping from one plane to a lower, and rising to the original plane again. When steam is turned on the body of water which has collected in this depression is set in motion, and carried to the engine, where damage is done or excessive strains set up. In any case, separators of ample capacity should be placed near the engine, so that they may collect any water in the pipes. An efficient separator is very desirable, as the entrainment of water by steam traveling at high velocities is always a source of anxiety to engineers. It is absolutely certain that after entrainment of water takes place, no possible arrangement of piping can be made to carry such water back to the boiler without the intervention of an efficient separator. A method which will somewhat mitigate this evil is to superheat the steam as it leaves the boiler; and should the quantities of water carried over not be too great, this will possibly obviate the trouble. Objections to superheated steam are, however, great enough to rule this method out with the majority of engineers.

The second division, as classified, of the causes of failure of steam pipes is *bad workmanship.* This may be subdivided again into bad workmanship at the mill, and bad workmanship by the coppersmith or pipe fitter who puts the piping in place. Bad workmanship at the mill is beyond the control of the users of steam pipe, whether that pipe be made of copper or of steel, and the following remarks are equally applicable to the manufacture of both kinds of pipe. It is nothing short of criminal on the part of the manufacturer of piping to neglect taking all the precautions possible to inspect the material before, during, and after the process of manufacture. Possibly this is done, but I regret to state that such is not my belief. On the contrary, my belief is that inspection at the mill is not rigid enough, and that is why we have some of our failures of steam pipes.

The builder of a steam vessel, who installs all machinery, makes all connections, etc., is held responsible for this machinery, piping, etc., until the vessel is de-

*Read at the eleventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 19 and 20, 1903.

livered, and frequently for a much longer time. Should any part of the piping fail, possibly causing loss of life, the builder is held responsible. Does this not seem unjust? Providing that the fault be in defective piping, the onus of blame should be placed on the manufacturer of the pipe, and he should be obliged to pay for the damage done. This method, if enforced, would undoubtedly have the desired effect of better inspection at the mill and the production of better piping. Regarding bad workmanship by the coppersmith, it has been my observation that the greatest number of cases of bad workmanship in copper piping are directly connected with the brazing of flanges to pipes. The copper is frequently injured by excessive heating. To what extent the tensile strength of the copper is lessened by such bad workmanship it is very difficult to ascertain, but when such cases are discovered, however slight the burn, it is imperative to condemn the work. The heavier copper piping is, the greater danger there is from "burning" during the process of brazing joints, and hence further danger in its use for high steam pressures. The fitting of steam pipes of all kinds is a very important matter. Through the careless work or bad judgment of pipe fitters, strains are brought on piping which are a constant source of danger. Expansion may not be allowed for. Joints made up where flanges do not meet fairly. Proper allowance not made for gaskets. The making up of joints before vessels are launched and no allowance having been made for possible change of form. These are a few instances of bad judgment or carelessness of pipe fitters, and they might be multiplied. The inspection of this piping during the time of putting in place is therefore important, and should receive the constant attention of individuals who first of all possess the knowledge of what is required, and, secondly, whose duty it is to see personally that it is put in accordingly.

The third division, as classified, of the causes of failure of steam pipes is *defective material.* We may consider all material defective which fails to satisfy safely the necessary conditions of its use. The failure to comply with these conditions may be due inherently to the *quality* of the material or to the *kind* of material used. For the first of these we must hold the mill responsible, and for the second the designer. The material worked up into piping, whether of copper or steel, should be, and no doubt is, subjected to tests to prove its fitness for the purpose required. The question then arises: are these tests sufficiently severe to develop the possible fact of weakness or positive fracture? Should it not be made an absolute certainty at the mill that all steam piping shall stand the pressure for which it is intended? There is only one satisfactory method of doing this, and that is to subject each section of pipe to, say, not less than five times the working pressure required. As a matter of fact this is never done unless under direct instructions of the consignee. As before remarked, a characteristic or tendency to split longitudinally has been observed in solid-drawn copper piping of large diameter, when subjected to high pressures, and this tendency seldom exhibits itself at the initial test. Nevertheless, the initial test will undoubtedly develop an existing weakness in however small a degree, even though that weakness be not manifest. A second or a third test at the place where the piping is installed may then fairly be expected to cause fracture in piping which is inherently weak. All steam pipe which is "made up" by the coppersmith should be tested in the same manner and as many times. The fact that a pipe fractures under a water-test pressure should never be considered a misfortune, however much it may appear so. It is a warning to be heeded, and the interpretation of the warning is to insist upon having better material and better workmanship.

I may now briefly enumerate some points in the general design, as well as the material entering into the construction of steam pipes, which will practically in-

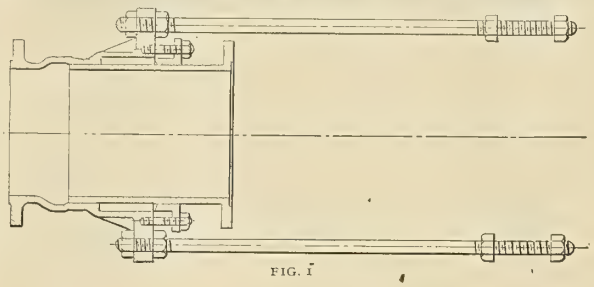

FIG. 1

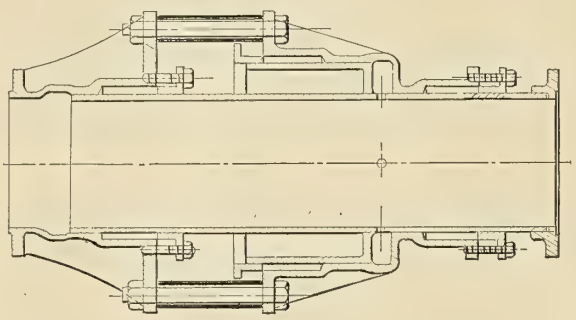

FIG. 2

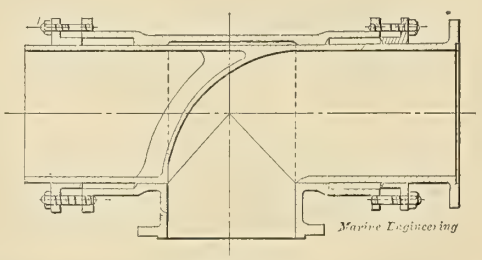

FIG. 3

sure their integrity under the most severe conditions of service, if properly put together. In making a general arrangement of steam pipes two requirements of vital importance should be borne in mind, viz., ample allowance for expansion must be made, and, if possible, there should be no pockets in the steam line. Permanent set will occur when metals are strained beyond the limits of their elasticity, hence the absolute necessity of proper attention to *expansion.* Should permanent set occur, it is only a matter of a short time till fracture takes place, due to the brittleness thus engendered. Metals of all kinds, subject to great variations of temperature and to varying strains, are constantly changing their molecular structure. In copper piping, therefore, where the elastic limit is so low, this should be neutralized by annealing the pipe at well-ad-

vised intervals. The weight of piping and connections should be carried by carefully-arranged hangers suspended from deck beams, spaced at frequent intervals. These should allow perfect freedom of movement, and at the same time be constructed so that the vibration will be absorbed.

An expansion joint made in either of the forms shown at Fig. 2 or Fig. 3 is a very satisfactory method of allowance for expansion, provided that there be a good packing in the stuffing box. It will be noted that either form is perfectly balanced. There are several good packings in the market for this purpose, but one notably so. This is a flexible metallic packing very much in use. Stuffing boxes for this purpose should be exceptionally deep, as it is not necessary then to pack them so tightly, and as a consequence a freer movement is permitted to the sleeve. The expansion joint shown at Fig. 2 has an enlargement cast on the sleeve. This forms a piston at the end of the sleeve adjacent to the casting having the large stuffing box. The end of this

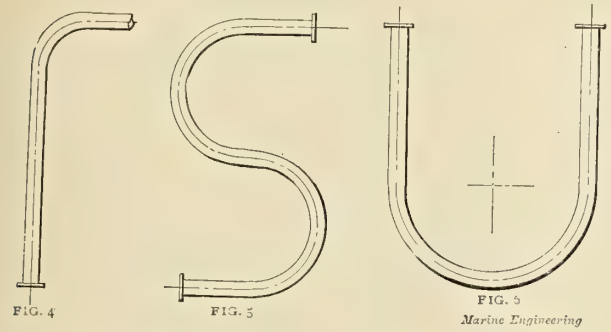

FIG. 4 FIG. 5 FIG. 6

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piston next to the large stuffing box is open, and is guided by same. In the sleeve below the piston, holes are drilled which permit the admission of live steam. The area of the piston on which the steam acts must be made equal to the area of the main steam pipe, and so, while permitting perfectly free expansion, it is also perfectly balanced.

The expansion joint at Fig. 3 is more simple than that at Fig. 2, and may be used to great advantage where a right or more acute angle is required in the main steam pipe. The sleeve is simply extended through the main casting, and has a stuffing box on both ends. In the sleeve is cast a deflective diaphragm turning the steam into the side branch. By giving a few figures it will be readily seen how important a function the balanced expansion joint performs, the importance of this function increasing rapidly as the diameter of the piping increases. Take for example a 15-inch steam pipe with 200 pounds working pressure of steam. The area of 15 inches = 176.78; then,

$$176.78 \times 200 = 35.356 \text{ pounds.}$$

or about 15 3-4 long tons unbalanced load on the steam pipe. With the ordinary type of expansion joint shown at Fig. 1, this unbalanced load must necessarily be taken up by the preventer bolts, subjecting these bolts and the castings to which they are attached to this strain. Two other good methods of allowance for expansion are shown at Fig. 5 and Fig. 6, which are simply an S bend and a U bend, respectively. These should be used only in moderate-sized piping, as the larger the diameter of the pipe the more rigid it becomes, this rigidity being enhanced by the necessarily increased thickness of the material. An apparent drawback to this form is that it occupies much more space than an expansion joint, and the claim cannot be made that it is any lighter.

With the perfection to which the *manufacture of steel pipe* has been brought, the ideal steam pipe for high pressures has been realized. Add to this steel flanges welded to the pipe, each pair of flanges being made male and female, and having a wire insertion gasket between them, and we have reached the acme of steam piping at the present stage of steam engineering. It is true that in mercantile work such piping with welded flanges is too expensive and difficult to get to be used in the majority of cases. A good substitute is, where

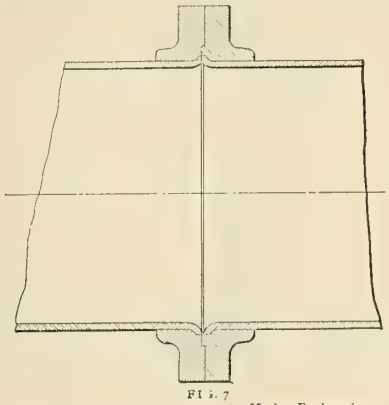

FIG. 7

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the pipe is expanded into the flange and turned over into a recess, formed in the flange for this purpose, as illustrated at Fig. 7. This method has the very decided advantage of being readily fitted at the place of installment. By kind permission of the Chief of the Bureau of Steam Engineering, I append the principal rules relating to steam pipes issued by that bureau, and which seem particularly well fitted to mercantile requirements as well as to that of the navy.

SPECIFICATIONS FOR COPPER PIPES.

1. The inspection must conform to the "General Instructions for the inspection of material under the cognizance of the Bureau of Steam Engineering."

2. The pipe must be made of Lake copper, and a chemical analysis must show that the metal is 99.5 per cent. pure copper. One analysis will be taken from each lot of 2,000 pounds or less.

3. The pipe must be free from indentations, cracks, flaws, or other surface defects inside and outside, perfectly round, of the specified diameter and thickness in all parts. All straight sections of pipe 6 inches in diameter (inside) or less shall be seamless drawn.

4. Each pipe must withstand an internal hydraulic pressure which will subject the metal to a stress of 6,000 pounds per square inch, the test pressure being calculated by the following formula for thin hollow cylinders, but in no case will a test pressure of over 1,000 pounds per square inch be required.

$$p = \frac{2ts}{d},$$

in which

p = safe internal pressure;
d = inside diameter in inches;
s = safe tensile strength of material = 6,000 pounds per square inch;
t = thickness of pipe in inches.

Every pipe must be perfectly tight under pressure and show no signs of bulging, cracks, flaws, porous places, or other defects.

5. A strip 1 1-2 inches wide will be taken from each lot of 2,000 pounds or less of pipe, and must stand the following tests:

(*a*) If less than half an inch thick, it must stand bending flat back cold after being annealed.

(*b*) If half an inch and over, it must bend back after being annealed until the ends are parallel and the inner radius of the bend is equal to the thickness of the piece.

(*c*) In every case the ends of the bending test pieces shall stand hammering down hot to a knife edge without showing signs of cracks.

6. Pipes of 2 inches inside diameter and over, for steam or feed pipes or other such high pressures, are to be subject to tensile tests, one piece of pipe from each lot of 1,000 pounds or less being selected to represent the lot. If the pipes are from 2 to 6 inches inside diameter, the test pieces are to be cut longitudinally. If over 6 inches inside diameter, they will be cut circumferentially. The test pieces will be heated to a cherry red and straightened when hot, then machined to the shape shown in the sketch, care being taken to have the brazed seam, if any, between the measuring points.

7. For thicknesses up to and including 1-4 inch, the width of the narrow part of the test piece shall be about 1 1-2 inches. For thicker pieces the width shall be such as to give a cross section of about half a square inch, but the breadth shall not in any case be less than the thickness. The rolled surfaces are not to be machined, but to be left in their original condition.

8. The test piece must show an ultimate tensile strength, after being annealed, of at least 28,000 pounds per square inch for all pipe, and an elongation of at least 25 per cent. in 8 inches in the case of seamless pipe.

9. *Thickness.*—Every pipe must be of the specified thickness in the thinnest part. The tolerance for excess of thickness will be allowed as follows:

Pipes up to 15 B. W. G.	12 per cent.
15 to 12 B. W. G.	10 " "
12 to 9 B. W. G.	8 " "
9 to 7 B. W. G.	6 " "
7 to 00 B. W. G.	5 " "

10. *Weight.*—The weight of every pipe must be at least equal to the calculated weight, on a basis of 1 cubic inch of copper pipe weighs .320 pound. An excess of weight equal to 5 per cent. of the calculated weight will be allowed.

SPECIFICATIONS FOR SEAMLESS STEEL AND LAP-WELDED STEEL STEAM PIPES.

1. *Material.*—(*a*) The seamless pipes must be made from solid billets or disks of perfectly homogeneous steel, and cold drawn or hot rolled, as specified in the order.

(*b*) The lap-welded steel pipes must be made of steel of homogeneous quality, and of the grade which is found to insure the soundest welds. The skelp must be rolled true to gauge.

2. *Surface Inspection.*—The pipe must be free inside and outside from all surface defects which would materially weaken it or form starting points for corrosion. The defects to be especially avoided are the same as those mentioned under the head of defects in boiler tubes. The pipe must be perfectly round and vary not more than 1 per cent. above or below the gauge.

3. The following tolerances will be allowed below the specified thickness:

Pipe of all diameters not over 3 inches outside diameter, tolerance .01 inch below.

Pipe 3 inches to not over 5 inches outside diameter, tolerance .02 inch below.

Pipe 5 inches to not over 7 inches outside diameter, tolerance .03 inch below.

Pipe 7 1-2 inches and over, .06 inch below.

4. *Weight.*—The weight will be calculated from the specified dimensions and thickness, assuming that 1 cubic inch of steel weighs 0.283 pound. A tolerance of 3 per cent. under and 7 per cent. over weight will be allowed for all pipe over 4 inches in diameter, and a tolerance of 3 per cent. under and 5 per cent. over weight will be allowed for pipe 4 inches outside diameter or less.

5. *Hydraulic Test.*—Every pipe must be subjected to an internal water pressure of 1,000 pounds per square inch, without showing signs of bulges, cracks, or other defects.

6. *Other Tests.*—Pipe 4 inches outside diameter and less will be tested in lots, and in the same manner as prescribed for steel boiler tubes. Pipes over 4 inches outside diameter may be tested in lots of 10, four pipes being selected from each lot and care taken that the pipes selected for test have had the same treatment as the remainder of the lot, *i.e.*, that they must not be annealed or softened by slow cooling unless the others have been treated in the same way. If the inspector has any doubts that the pipes have all received the same treatment he will test each pipe singly.

(*a*) Two test pieces will be cut circumferentially (when it is practicable to get a strip of the requisite length) from the ends of two different pipes, straightened when hot, and machined to shape and to a width of 1 1-2 inches. For thickness up to and including 5-16 inch, the length between the measuring points will be sixteen times the thickness. For thickness greater than 5-16 inch the length between measuring points will be 8 inches. In the case of welded pipe, the test piece must be cut so as to leave the weld in the middle. The test must show a minimum tensile strength of 48,000 pounds per square inch, and an elongation of at least 12 per cent. in 8 inches or 15 per cent. in 5 inches.

(*b*) Two test pieces of a width equal to three times the thickness of the metal in the pipe cut circumferentially from the ends of the other test pipes, so as to include the weld, if any, shall stand bending cold at the weld to an inner diameter equal to thrice the thickness of the metal, without showing cracks on the outside of the bend.

7. The failure to pass these tests in a satisfactory

manner will reject the lot, unless the manufacturer desires to test each pipe separately, in which case a tensile test shall be taken from one end and a bending test from the other, and the pipe accepted or rejected accordingly.

8. If ends of pipes are flanged, swaged down, swelled, upset, or reinforced, they will be inspected after this work is done, to see that no damage has been done by this process.

9. All cold-drawn pipes must be annealed in retorts or in an improved furnace in which the flame does not strike them.

10. Each pipe will be stenciled with the name of the maker and the number of the government requisition, or name of the vessel for which it is intended, and its location mark when necessary.

NORWEGIAN STEAMER BLAAMANDEN, WRECKED ON THE NOVA SCOTIA COAST.

11. The inspector's identification stamp and the United States anchor stamp will be put on the cases in which the pipes are shipped. If the pipes are shipped in box cars containing no other freight, the cars will be sealed and the anchor stamp put on the seal. In this latter case it will not be necessary to box or crate the pipes.

Wreck of the Blaamanden.

On this page is given a view of another one of the many wrecks to be added to the long list of those occurring on the Nova Scotia coast. It is of the Norwegian steamer *Blaamanden,* which went ashore about 100 miles from Halifax, in a cove, during a thick fog.

The wreck occurred over a year ago. Attempts were made to raise the vessel, but these proved fruitless, and the ship was a total loss. This, it might be added, is the general fate which befalls any vessel striking the rock-bound shores of Nova Scotia, for it is seldom that a vessel is ever released when once she grounds.

ALUMINO-THERMICS,

OR

Production of High Temperatures by Burning Aluminum, and the Application of this to Engineering and Metallurgy.*

BY DR. HANS GOLDSCHMIDT, OF ESSEN-RUHR, GERMANY.

The two elements of most frequent occurrence on our planet are oxygen and aluminum. By producing in a suitable manner the chemical combination of these two, a temperature is created which is about equal to that of the electric arc light. On this discovery is based the new science called alumino-thermics. The proper manner of combining aluminum with oxygen is not by taking the atmospheric oxygen, but the solid oxygen contained in the oxides; these are mixed with finely granulated or pulverized aluminum. The resulting mixture is the heat producer and is called thermit.

The next aim is to produce this great heat in the simplest and most efficacious manner and then to discover the fields on which it can be applied to most advantage.

The first important discovery in observing the properties of this mixture—thermit—was that, when ignited in one spot, the combustion continued throughout the whole mass without any supply of heat from outside. The mass is placed in crucibles which are not in contact with any external source of heat, and the combustion, once started, embraces the whole mass in a very short time. This is the essence of alumino-thermics.

In the crucible after the reaction there are two layers. The bottom one is pure metal of equal weight to, but occupying only one-third of the space of, the top layer, which is now oxide of aluminum, so-called corundum.

*Extracts from lecture delivered at the annual meeting of the American Society of Mechanical Engineers at the Stevens Institute, Hoboken, N. J., December 3, 1903, by the inventor.

These two layers whilst still liquid are poured rapidly over the rim of the crucible. It is not difficult to distinguish between the slag which flows first and the brightly glittering overheated metal.

(To demonstrate the heat created by this chemical reaction, the speaker used thermit to burn a hole through a 1-inch wrought-iron plate.)

You will notice that in this case the crucible is tapped from the bottom so as to allow the pure iron, which has a temperature of about 5,400 degrees F., to run out first. The hole is perfectly smooth edged; the heat is so concentrated that the plate is still cold after the reaction.

Nearly fifty years ago attempts were made to apply the reducing properties of aluminum. Without exception the experimenters heated their compounds externally. The reaction was always so violent that they could only operate with very small quantities. It will easily be seen that to arrive at alumino-thermics on a commercial scale from such a starting point required patient study and assiduous work. Each of the mixtures, although made according to simple chemical rules, required studying out by itself. The formulas for gunpowder or dynamite sound fairly simple, but it requires more than a mere mixture of the ingredients to obtain any effect sufficient for industrial requirements; not as if thermit were an explosive—you can throw it into the kitchen fire and it won't burn.

In all exothermic processes the physical properties of the ingredients, in this case particularly those of the oxides, want considering. Then the methods of manufacture have to be worked out for each case.

In the following I am going to illustrate by practical demonstration a few of the applications of the thermit process; to give an account of the entire field of its utility would go beyond the scope of a single lecture.

The applications may be roughly divided into two main divisions, the one concerning the metallurgist, the other the engineer. The latter application may be summarized in the word "welding." The study of the metallurgical application preceded that of the other.

Amongst the pure metals produced by the aluminogenetic reaction I may mention in the first instance chromium free of carbon as having already found a market in this country. It is used in the manufacture of particular qualities of chromium steel with a limited percentage of carbon. For instance, it is considerably used for self-hardening tool steel with 5 to 6 per cent. chromium, about twice that quantity of tungsten and only .6-.7 carbon. . . .

This first division appertaining to metallurgy I shall abandon for the present in order to acquaint you with the process which has received the widest attention and practical application—the thermit welding process.

Considering the innumerable details connected with the application of so new and practically unknown a force, it is not surprising that only since about a year ago the process has been introduced on a large and commercial scale.

The most important of these welding processes is the one by which a continuous rail—a necessity of modern trolley-road construction—is simply, cheaply, and effectively obtained. Engineers in this country, in which no less than 25,000 miles of single track are in existence, are watching the good results obtained in Europe with this system. European authorities recognize its advantages over all its competitors, about 20,000 joints having been welded by this process since about a year ago in forty cities of the old world. . . .

A marked advantage enjoyed by this system is the absence of any bulky equipment; all that is required is a crucible, a mold box, and, in some instances where a complete butt weld of the head of the rail is desired, a rail clamp. All these materials, including the necessary quantity of thermit, can easily be moved on a hand truck. Each weld, according to section, requires from fifteen to twenty pounds of thermit.

Even where a rail clamp is used the time employed is less than that necessary for fixing fishplates and copper bonds. The mold is made according to a model designed specially for each section. Its two parts, one on each side, firmly enclose and exactly fit the rail. They are made on a large scale by manufacturers of refractory earthenware, or, according to the requirements of the trolley lines, in the repair shops, by tamping an ordinary mixture of china clay and loam into a sheet-iron case placed over the model, which has afterward to be dried during a couple of hours at a temperature of some 212 degrees F. The cost is only a few cents.

The thermit iron running out of the crucible flows round the web and foot of the rail and, melting them, forms one mass with them. The liquid slag which follows the metal is diverted to the top of the rail and brings the latter to welding heat. The whole section is thus heated equally and the rail ends will not buckle. . . .

(Two rails were here welded by thermit.)

Working without clamps the time consumed per joint equals three-quarters of an hour for one man; trained squads of four men, including foreman, did not use nearly so much time. At $1.50 per day the wages item of cost is ten cents per joint. The use of the clamps doubles this amount. All other labor remains the same whether clamps are used or not.

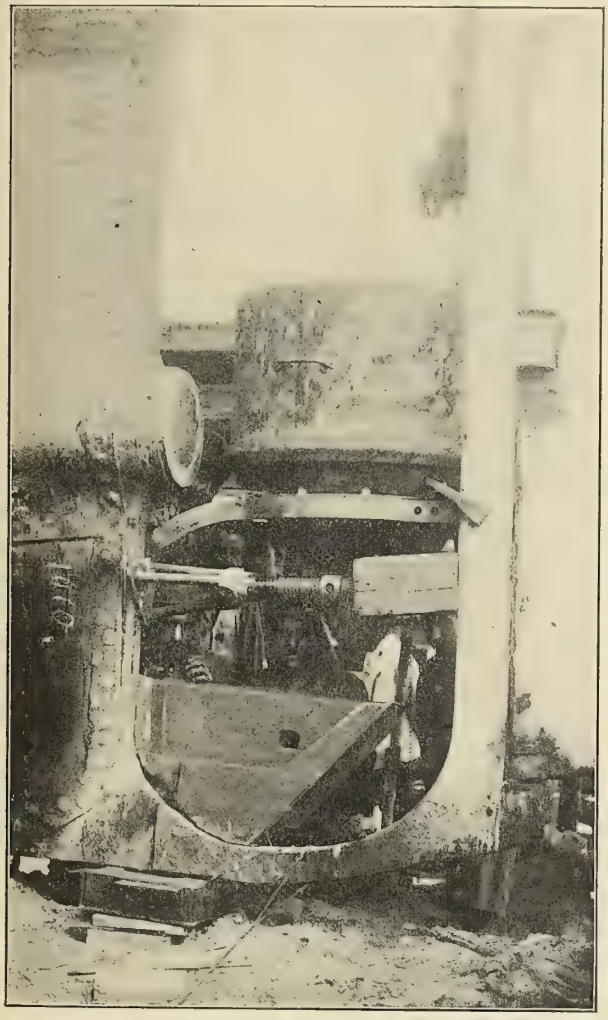
The mold, which must be dry and porous, is screwed on to the rail and the rims touching the rail are carefully smeared with clay. Before doing so, however, the rail ends are cleaned of dirt and rust with a wire brush and slightly warmed; a sand blast is superfluous.

In case the tops of the rails are to be butt-welded the section has to be filed. This is all that is required in the way of preparatory work. A true alignment of the rail is an indispensable precaution. The rails require no bolt holes, as no provisional fishplates are necessary.

You will recognize that none of this work demands special training, and that in this country, as in Europe, the trolley companies' men will be easily able to do it. A certain supervision to see that it is done carefully is a matter of course. The welding is done automatically and does not require the trained eye of an expert welder. In case of wet weather the protection of a few planks is desirable to prevent the mold and thermit getting wet.

The next and only remaining appliance necessary for thermit welding is the crucible. This consists of a sheet-iron mantle lined with magnesia. It is of simple construction, the lining being introduced by tamping it round a cone which is suspended in the middle of the mantle. The bottom is formed by a hard magnesia stone provided with an exchangeable outlet, which will stand nine to ten runs. The crucible, with the cone

in it, is placed in the furnace for only two hours and finally brought to glow heat. It is then ready for use. Crucibles will stand about twenty-five reactions, and the wear and tear will, therefore, amount to only a few cents per joint. The thermit is supplied in small bags



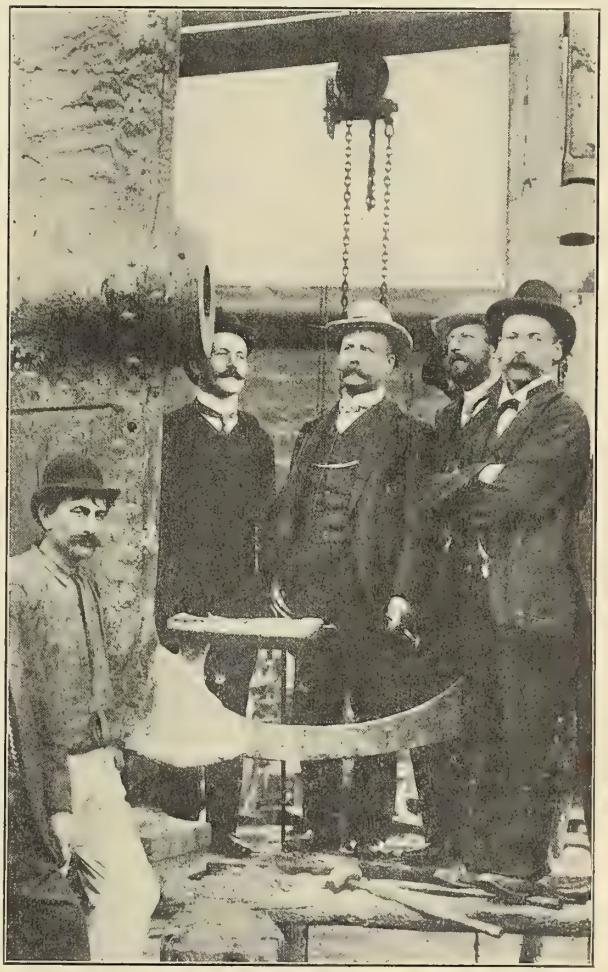
CRUCIBLE AND ONE-HALF THE MOLD IN PLACE.

containing the exact weight which is needed to effect the weld. These are called welding portions, and are sold as such to the trolley companies. The companies who make their own crucibles and molds will, therefore, have to pay freight only on the welding portions, which is considerably less than that on fishplates and bolts. The Essen works have a plant to supply over 500 welding portions daily.

The strength of the weld is about 80 per cent. of the strength of the original material. The shoe welded on to the foot of the rail not only makes up for the remaining 20 per cent. but materially strengthens the rail at the joint. The head does not get softer, although it is brought to welding heat; the reason being that the operation takes place without the air having access to it. Test rods cut out of rails brought to welding heat with thermit prove that tensile strength and elasticity have not suffered; a fact which is confirmed by three years' practical experience on the road.

Steel girders for construction work can of course be welded in just the same way as rails. For really solid jointing equal to the strength of the girder itself welding is cheaper than riveting. There will be a wide field for this work in the United States as soon as the preparatory experiments and calculations have been made and officially sanctioned. After the experiments you have seen here you will acknowledge the immense saving of time in using the welding process as compared to riveting.

The next field of application I shall now touch upon is an exceedingly wide one—the repair of solid iron and steel objects. Thermit, as I told you, gives 50 per cent. of mild, very overheated steel with .1 carbon, which can be hardened if desired, for instance by an addition of manganese. *Whoever has a supply of thermit has a supply of liquid steel.* Accordingly foundries can correct faulty castings, machinery shops can mend broken or worn-out parts, and last, but not least, marine en-



AFTER WELDING THE STERN FRAME.

gineering works can repair large steel castings, such as crank shafts, and particularly broken stern posts.

Wherever the distance from construction shops is a matter of consideration, and in all outlying districts, this thermit is of particular value. Within the last few months regular ton orders have been received from

South Africa, where damaged machinery of all kinds has been repaired by it in the mining districts. In many cases cast iron has been welded.

Certain rules have to be observed in all repair work. First and foremost the slag should not be allowed to get mixed up in the plastic iron. An appropriate position of the runner and a little experience in the construction of the most effective shape of mold will prevent this. The mold must be made so as to allow the liquid iron which runs out of the crucible to flow freely round the flaw or fracture and to rise in the rising pipe. The latter must be large enough to hold sufficient metal, that the walls of the flaw, etc., are fused. The weld can be either effected by running the thermit iron round the ends of the piece in the shape of a ring, or by both running it between and around at the same time. The size of molds and quantity of thermit necessary for welding shafts up to 300 mm. diameter have been tabulated. A 12-inch diameter takes 190 pounds of thermit, giving 95 pounds of mild steel.

The most startling and at the same time most effective work done in the way of repairs by thermit is in connection with marine engineering. To weld broken stern posts of big transatlantic liners, or crank shafts or similar pieces, crucibles six feet in height with a capacity of seven hundredweight have been constructed. The reaction in these takes hardly longer than in a small crucible. The enormous advantage offered to steamship owners by such repairs will be apparent when it is remembered that a broken stern post would otherwise have to be replaced by a new one. Besides this expense the one incurred through loss of time, the steamer being laid up in dry-dock for weeks and weeks in order to have the new part fitted in, is very heavy indeed.

I now come to an application of thermit which differs materially from the ones I had the privilege of demonstrating to you up to now. That is welding wrought-iron pipes.

Of course, the heat of the iron if applied direct would destroy the thin walls of the pipe. Here, then, the corundum slag created on the top of the mass in the crucible comes into play. On being poured it has the properties of adhering instantaneously in a thin layer to any object that it comes in contact with, and of being impervious to liquid thermit iron. The sequence of operation is therefore changed, and the slag is made to flow out before the iron. The reaction takes place in a crucible with a solid bottom, from which the contents are poured over the rim.

To butt-weld the pipes the ends must be made to fit accurately on to each other and must be made bright with a file or emery paper. The two pipes are then firmly pressed together by the clamping apparatus, and the sheet-iron mold, well surrounded with moist sand, is attached. After pouring the liquid contents of the crucible, welding temperature will take place within a minute or two. The clamps then want tightening one turn of the screw and the weld is complete. The mold box is removed almost at once and can be used several times. The surrounding mass, containing the iron between the layers of slag, like the yolk in the white of an egg, is easily removed with a hammer. Such welds will stand pressure of hundreds of atmospheres; as a matter of fact as much as the pipe itself. About 30,000 to 40,000 pipe joints have been welded by this method, the advantages of which are, shortly, that the operation can take place anywhere, and that it is cheaper than a solid flange joint. The dimensions of the molds have been carefully worked out and tabulated for every size of wrought-iron pipe up to six inches diameter. Any workman will be able to make such welds after very short practice by carefully observing the few rules and directions printed in the pamphlets.

One of my associates, Mr. Mathesius, has specially devoted himself to studies concerning the improvement of iron and steel castings. These are obtained by introducing the thermit below the surface of the bath, and so producing a high temperature in one place. A box containing the thermit is fastened to an iron rod and held down on the bottom of the ladle.

For cast iron, and, in some cases, for steel, a special thermit is used which gives off an alloy of iron with titanium so that the titanium enters the liquid metal. The reaction takes place all through the contents of the ladle and thoroughly stirs them up in the space of a minute or two. Gases and particles of slag are driven upward so that the fluidity of the iron is increased. An increase of the temperature does not in reality take place, as the proportion of added thermit is only one-quarter to one-sixteenth per cent. of the total contents of the ladle. The effect of the titanium is to bind small quantities of nitrogen, to increase the fluidity of the cast iron, and to produce a finer grain.

Another application of the so-called "box reaction" is important for steel castings, and especially for casting large steel ingots, to prevent the familiar phenomenon of piping. In the heads of such blocks hollow spaces are found which mostly cause 30 to 40 per cent. of loss.

The thermit process as used for this purpose consists in introducing a box of so-called anti-piping thermit into a block with the aid of an iron rod, in exactly the same way as described before. According to the size of the block the box is suspended about three feet. The reaction is completed in this case in a few seconds. The box is introduced, of course, only after the piping has been formed. The head layer, which has already become solid, is broken through for this purpose. Immediately after the reaction is completed, steel, which is held in readiness for this purpose, is poured into the open hole. The method is really very simple, and one learns very quickly at which time to introduce the box. Moreover it is very cheap, only about ten pounds of thermit being required for blocks of ten to twenty tons weight. After the treatment relatively very small flaws were found, and only in the upper part of the block, so that the loss is only a very few per cent.

The method has also been applied for very large steel castings to revive steel which had become plastic in the runners. In this the anti-piping thermit is placed at the bottom of some risers, in an annular box with concentric walls, containing about two and one-half pounds of thermit.

The difficult operation of casting long stern posts of vessels can be facilitated by inserting in several places boxes of this thermit. On account of the long way steel has to travel it has a tendency to grow plastic. But coming into contact with thermit its temperature and thereby its fluidity is revived.

Italian-Built Cruiser.

The protected cruiser *Rivadavia,* built at Messrs. Ansaldo and Company's yard, Genoa, Italy, holds the record for speed in construction. The ship was contracted for by the Argentine Republic and the keel was laid March 10, 1902. On October 22 of the same year the vessel was launched, and on May 14, 1903, the dock trial was successfully run. Thus, fourteen months from the date of laying the keel the vessel was practically completed. The accompanying view was taken on May 12. In the same yard is being pushed the work on her sister ship, *Moreno,* shown at the middle of the engraving at the top of this page, and which was described and illustrated in the April, 1903, number of MARINE ENGINEERING. At the left of the engraving is the *Messhoudjeh,* at the right the *Rivadavia.*

SHIPYARD OF MESSRS. ANSALDO AND COMPANY, GENOA, ITALY.

PROTECTED CRUISER RIVADAVIA, BUILT FOR THE ARGENTINE REPUBLIC; VESSEL COMPLETED IN FOURTEEN MONTHS FROM DATE OF LAYING KEEL.

Marine Engineering

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WHILE the year closing has been a dull and in some cases a disastrous one to the shipbuilder, it has recorded many important steps in the advancement of marine engineering in both the general departments of hull and machinery. In the first place, the value of the experimental tank has been further demonstrated in this country by the results obtained at Washington with models of the new battleships, whereby an increased speed may be obtained at less horse power on the same displacement than in the ships built before this tank was in use. Doubtless the experimental tanks abroad have been the means of gathering valuable data, but the policy of the owners has been to keep such information private, which is quite the reverse of the practice at our Washington tank.

Again, in the closing days of the year, there was launched another leviathan, the greatest ship afloat, which is to fly the house flag of the White Star Line and has been named the *Baltic*, of 725 feet in length and about 40,000 tons displacement. As the succeeding years witness the construction of ships larger than ever before built, it is impossible to foretell what the limiting dimensions will be for size and speed. The above-mentioned ship is to be of but 16 1-2 knots speed; but the year also records a contract between the Cunard Line and the British government, by which that steamship company is to build and operate, under the English flag and patronage, two ships larger and faster than any vessels yet afloat. The dimensions of these vessels have not yet been finally decided upon, but it is understood that they will reach a length of 800 feet and be of greater displacement than the *Baltic*. Concerning the enormous power for driving these ships we will speak later on. Four large ocean steamers were launched this year from our Atlantic shipyards and but one now remains on the stocks. The Coast yards have had a light year, while the yards on the Great Lakes turned out a large tonnage.

Another important event in the year has been the signing of the contract of two 540-foot transatlantic liners for the Allan Line to be fitted with steam turbines. In Great Britain the turbine has met with success especially in its application to marine service; but as yet all boats so fitted have been either of the torpedo-boat or the coast and cross-Channel types. The report of the joint commission appointed by the British government and the Cunard Line to investigate the steam turbine with a view of fitting it on board the new Cunard liners is looked forward to with great anticipation, as the commission, composed of prominent engineers, is to carry on elaborate and comprehensive tests. One of the plans consists in testing two very similar new Channel steamers, one fitted with turbine engines and the other with reciprocating engines, for the purpose of comparing the coal burned, water evaporated, economy of operating, etc. Should this commission report in favor of the turbine, a most decisive step will be taken, as it is understood the power to drive these ships at the speed of 25 knots will be in the neighborhood of 60,000 or 70,000 indicated horse power. In this country reports have been made to the Bureau of Steam Engineering by boards delegated to witness the trials and investigate the machinerry of two types of turbines. These boards recommend that turbines be installed on some government ship for the purpose of further tests.

The long and hard-fought battle between the water-tube and Scotch boiler has had another severe conflict this year; and, taken as a whole,

the water-tube boiler has risen to a stronger position than ever before. The report of the Boiler Committee of the Admiralty has practically reversed the previous findings of this body, which were adverse to the water-tube, more especially the Belleville type. Through the wisdom of our navy in installing in our warships recently completed or completing water-tube boilers of several makes, the selection of the best types will eventually be ascertained. The American yachts are almost exclusively fitted with water-tube boilers; but, with one notable exception, on all merchant salt-water ships launched this year, except the smallest craft, Scotch boilers were installed. The ship owner is yet waiting for the navy to decide this vital question before he will leave the trusty Scotch boiler.

The restriction of the output of the oil fields, or rather the increased quantity required for the arts, has raised the price of fuel oil to a figure almost prohibitive for marine consumption, except in certain localities, notably among which is the Pacific coast. The very elaborate tests of oil as fuel conducted by the Bureau of Steam Engineering have been completed and the records are soon to be published. These tests are the most complete ones of the kind ever made and will form a valuable addition to the information on this subject.

Turning now to the auxiliary equipment, we find that engineers generally are paying more attention to this long-neglected subject. Breakdowns at sea of these numerous machines have been of frequent occurrence. The necessity of good design and workmanship is, we believe, better realized to-day than ever before; it is not only necessary to have a good machine, but to so place it in the engine room that the engineer or machinist may conveniently get at it. One thing has been definitely decided this year and brought to general attention, and that is the absolute necessity of keeping oil and salt out of water-tube boilers. This means that the distillers, evaporators, and separators should be properly designed and run, and that the condenser must be kept tight. While these simple statements have always been generally conceded, the full truth has not been realized. In Great Britain superheaters have been installed to some extent on board ship with marked advantage, but they have not been used in this country.

If during the coming year no startling innovation is made in marine engineering, the closing of 1904 would record most marked economies in marine engineering if the attention of engineers were directed to details.

PRESIDENT ROOSEVELT'S message to Congress contained much space devoted to the consideration of the American merchant marine, and he recommended that a commission be appointed, to consist of the Secretary of the Navy, the Postmaster-General, the Secretary of Commerce and Labor, and three members each of the House and Senate, which would investigate the general subject of our shipping and report at the opening of the next session of Congress what legislation, if any, should be enacted for the protection of our ships. While it is gratifying to shipping interests to see the attention which the Chief Executive has given to this subject, it is to be regretted that he recommends the final action be delayed. The public generally has become very well posted, particularly in the last few months, on this subject, and it is to be assumed that our legislators have kept apace with public opinion, in which case it is high time that immediate action be taken. A general realization of present conditions has been slow, yet the acquiescence of all interested to practically one form of remedy has, we believe, been obtained. Also, the crying need for protection has become still more distressing; and, while conditions have been going from bad to worse, it is the general opinion that the next step will be ruin to the shipbuilders.

The movement has some splendid champions and leaders in and out of Congress. Senator Frye's reply to a reported conversation with the director of one of the largest transatlantic lines, in which the director decries any movement on the part of the United States to protect American shipping, shows how extremely well posted the Senator is with the history of our own and foreign maritime subsidies. It has often been stated that bills brought before Congress for the protection of American ships were defeated through the influence of the great transatlantic, foreign-owned lines. This result is naturally to be expected, but such interference only strengthens the armor of the protectionist, as it shows how foreign companies are profiting through our unprotected shipping. We urgently recommend to Congress that the investigation of the present condition of marine affairs be immediate.

A Bad Crank Pin.

Editor MARINE ENGINEERING:

Several articles that have lately come to my attention through your valuable paper, in connection with repairs to marine engines, remind me of a job that I saw, while visiting a large shipyard in the far East, that was a little out of the ordinary both as regards the means employed to locate a weak spot in an engine, and the business methods of the company which made the repairs.

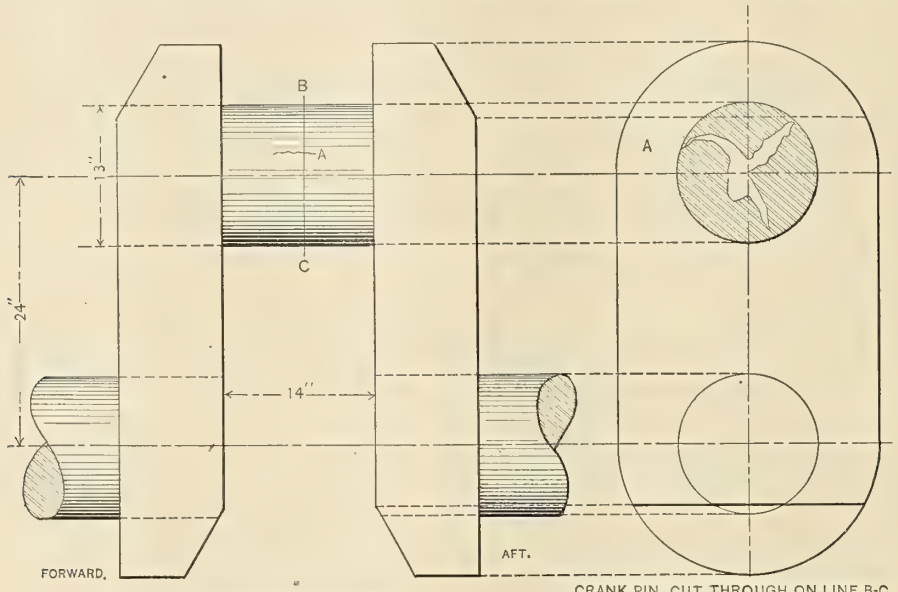
The job in question came from a large, single-screw ocean freighter, and was the intermediate section of crank shaft of a large triple-expansion three-cylinder engine. I should say the engine was about 30, 46, and 72 inches by 48 inches stroke, the crank shaft being built up and in three sections, with a coupling between the high-pressure and intermediate-pressure, and another between intermediate-pressure and low-pressure engines. The engine had run as well as usual, and the outward voyage had been an uneventful one until a strong northeast monsoon was struck, the ship being then well up the China sea.

As the sea became unusually heavy the engines were eased to three-quarter speed, when, shortly after slowing down, the crank pin of the intermediate engine was found to be unduly heated, and it also became apparent that the temperature of the pin was fast rising. The speed was then still further reduced to one-half, and extra oil and water were administered to the heated pin in heroic doses. This reduced the temperature to a considerable extent, and it was deemed advisable to try and make the few remaining knots to port at a reduced speed rather than risk taking anything adrift in the heavy sea then running.

On mooring the ship, after reaching port, the brasses were opened out for examination, when it was found that they showed slight cutting of the upper and lower halves for a length of about 2 or 2 1-2 inches all the way around and nearly in the center of their length. This would, of course, indicate that the trouble was to be found with the pin.

On jacking the engine around, the pin was found to be in perfect condition, except for a very fine, hair-like, wavy line, as shown in the sketch about in the position marked *A*. By rubbing the hand carefully at right angles to this line it could be readily noticed that one edge of the apparent crack was higher than the other and had been acting as a scraper in the brasses, thus causing the heating. It appeared to be a "cold shut," or lamination in the steel, and on a very close inspection there seemed to be a very minute portion of the metal missing along the edge.

Mr. M., the superintending engineer of the works, was called aboard and asked his opinion as to what he thought was wrong with the pin. After he had made a very careful examination of both pin and brasses and asked several questions relating to the weather encountered on the voyage, and when it was noticed that the pin was beginning to heat, he gave as his opinion, without the least hesitation, that the pin was hollow in the center—a bad forging—and was therefore unsafe and would require to be replaced with a new one. This at once called forth some very warm arguments between himself on the one side and the captain and the chief engineer of the ship on the other side. The captain and the chief then asked Mr. M. why he was so positive that the pin was a bad forging.



CRANK ON TOP CENTER

CRANK PIN CUT THROUGH ON LINE B-C. SHOWING HOLLOW PORTION

Marine Engineering

"Well," said he, "you had no trouble with the pin during nearly 15,000 miles of steaming, and the pin did not give any trouble until the engine began to race after you got into bad weather; then you found it beginning to heat all of a sudden."

"Yes, yes, we will admit all that," said the chief.

"Well, then," remarked Mr. M., "when that pin started to heat, then it started to let go. And, furthermore, I will show you that it is 'gone,' if you will let me, and I will now make you the following proposition: I will drill out the old pin and shrink in a new one;

then I will put the old pin in a lathe, cut it in halves through the crack, and when you see the two halves of that pin, and it then proves to be a bad one, then you are to pay us for time and material on the whole job. On the other hand, if the pin proves to be of good material, and perfectly sound, then I will make your owners a present of the whole job, complete and ready for sea."

At first the chief demurred, and thought the pin and brasses could be "dressed up" and made a good job. But Mr. M. was immovable, and promptly told the captain and the chief that, inasmuch as he had spent twenty-six years in building up a reputation for his firm and himself, he did not propose to jeopardize it for one crank pin. It was then decided to remove the old pin and put in a new one, and, the shaft being in three sections, the intermediate was taken adrift at once.

I had become greatly interested in the job, and through the courtesy of the superintendent followed it along as the work progressed, and made a few sketches for my own benefit. I was at the works when the halves of the old pin came out of the lathe, and I now reproduce, in the present sketch, the condition of it, as nearly as I can from memory and measures taken at the time.

The pin, after being put in the lathe, was cut through the flaw marked *A*, on the line *BC*, and referring to the cross section, it will be readily seen the pin was certainly in bad shape. I took a sheet of stiff white paper, and with the aid of a light hard-wood mallet I obtained a very good impression of the flaw, as shown in the cross section of the pin. This flaw, or, more properly speaking, the area of it, I obtained with a planimeter.

The area enclosed by the bad portion I found to be 15.89 square inches, or a reduction of the true area of the pin of about 12 per cent. The edges of the flaw, after careful inspection, were found to be 1-8 inch from the finished portion or surface of the pin, except at the point *A*. How much longer this pin would have continued to hold on can of course only be guessed at, and what would have happened had there been a dissembling of parts through its letting go altogether is of course another guess, but I think it would have been just as well to stand from under. The shop in question had at the time nearly five years' work ahead, nearly all of which was new and hurried, and, under these circumstances, could not, of course, have been begging for work. Mr. M. should have been heartily thanked for saving the owners of this ship a probable chance of having the vessel drifting about helpless for a week or two in the China sea or the Indian ocean, and finally furnishing a nice fat salvage job for some lucky but often despised ocean tramp steamer.

Chefoo, China. E. A. BLACKWELL, U. S. N.

German Launch.

Editor MARINE ENGINEERING:

The description of the German launch *Moguntia*, given in your number for November, just to hand, is an interesting illustration of how ideas tend to repeat themselves.

In the year 1874 or 1875, or it may be 1876 (I have not the papers at hand just now and cannot verify the date), a paper was read before the British Institution of Naval Architects by a gentleman from Manila advocating exactly the same basis of design as is called for in the case of the German launch of the tetrahedral form. The writer of the paper spoke of having built at least one yacht on the principle, and I remember being very much taken with the idea. In the course of conversation afterward I found that the idea was even then far from new, the Cornish luggers of that time being built upon a modification of the same principle. It was pointed out that the geometrical base of the form consisted of making the cross sections of the vessel of triangles, lessening in depth and increasing in width from forward aft, so that the load-water plane formed a triangle. It was also pointed out that, as modified to suit exigencies in a sailing craft, this led to what was called a raking midship section; that is, a line drawn on the sheer plan from the base upward, so as to pass through the point of greatest breadth on each horizontal plane, would be inclined aft.

Altogether I built several small sailing yachts as near this principle as I dared to go, but the results were disappointing; in the first one the greatest depth was carried too far forward and the greatest breadth too far aft, and the boat was very bad to handle in any little jump of a sea, while in smooth water with a fresh breeze, as she heeled, she put her head down and ran off her helm. In light winds the excessive skin friction was too much for her. Successive experimental boats left the impression that a midship section raked at about 45 degrees was as much as one could venture, and it was always a question whether the result was worth the trouble.

These conclusions of course refer only to sailing craft, and I should think that there would be more useful scope for this principle in steam craft intended for speeds well above the normal wave-making point.

WILLIAM CAMPBELL WILSON.

Thetford, Norfolk, England.

PERSONALS.

Robert G. Griswold, who formerly held the position of inspector of machinery, U. S. N., at the works of the Harlan and Hollingsworth Company, has been transferred to a government position at the yard of the Fore River Ship and Engine Company.

Walter H. Whiteside, manager of the retail and supply department of the Westinghouse Electric and Manufacturing Company, has also been made the general manager of the Sawyer-Man Electric Company, and has added the duties of this new office to his former ones. He has been connected with electrical trade interests for nearly twenty years and with the present company for many years.

H. F. J. Porter, who has been associated with Westinghouse interests since the first of the year, and has held the position of assistant manager of the publishing department, with offices in East Pittsburg and 10 Bridge street, New York, has been made second vice-president of the Nernst Lamp Company, of which enterprise Mr. George Westinghouse is president, with the duties of general manager and headquarters at Pittsburg. He assumed charge on December 1.

THE DESIGN OF MARINE MACHINERY.

BY W. F. DURAND.

[11] The Stephenson Link.

The types of valve gear with which we have been thus far concerned are only adapted for continuous rotation in one direction. Our main purpose has been, in effect, the study of the movement of a valve actuated by a single eccentric, simply as a first step toward the study of more complex forms of gear suitable to motion in either direction and with varying degrees of expansion ratio. As the first of such type of gear we shall take the Stephenson link. As shown in skeleton in Fig. 20, this gear has two eccentrics, P and Q, located at equal angular distances, KP and KQ, from the crank C. Each eccentric gives motion, through an eccentric rod, to one end of a curved bar or link, AB: P to the end A, and Q to the end B. From some intermediate point on this link, as H, motion for the valve is taken.

The first step in the study of this gear consists, therefore, in an examination of the motion of the point H, or at least of the component of the motion which is effective along the

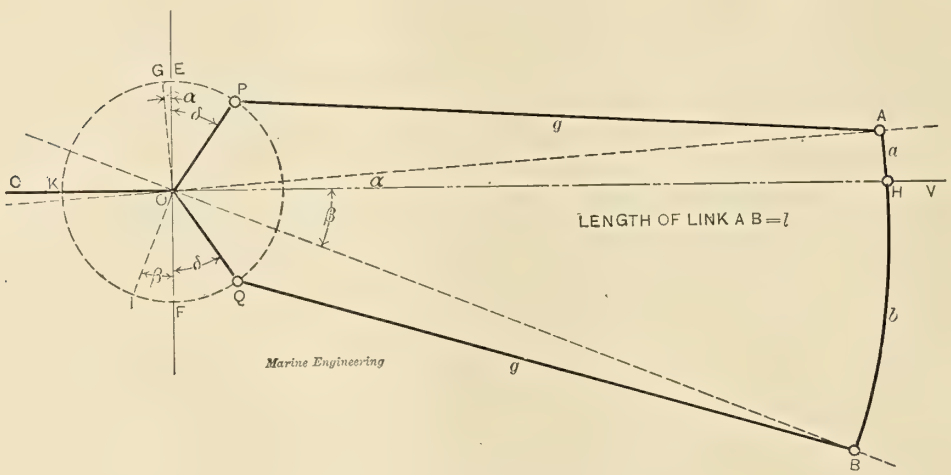


FIG. 20.

line of movement of the valve rod, OHV. The exact investigation of this problem would prove very complex and tedious, and it is found advisable, therefore, to accept an approximate treatment, which is very much simpler, and which gives the motion with all the accuracy required for most practical purposes.

In this mode of treatment we first consider the component of the motion of A along the line OA, and that of B along the line OB. That is, we consider P and Q as simple eccentrics, the first giving a certain motion along the line OA, and the second along OB. Denote the angles HOA and HOB by α and β, as shown. Then the angular advance of P relative to the component motion along OA is to be reckoned from a line OG perpendicular to OA, or at an angle α to the left of OE. Similarly the angular advance of Q is to be reckoned from a line OI perpendicular to OB and at an angle β to the left of OF. The angular advance of P for the component motion along OA is therefore POG or $(\delta + \alpha)$, and that of Q for the component motion along OB is QOI or $(\delta + \beta)$.

Referring to the equation for the movement given by a simple eccentric, [4] (2), it follows that the component motion along OA due to P is:

$$y_1 = r \sin (\theta + \delta + \alpha) \quad \ldots\ldots (1)$$

while the component motion along OB due to Q is:

$$y_2 = r \sin (\theta + \delta + \beta) \quad \ldots\ldots (2)$$

This latter equation, however, would be for motion of the crank in the direction from K to Q. If we suppose the crank to be moving in the direction from K toward P, then for Q we must consider θ as negative, and we shall have for the component due to Q:

$$y_2 = r \sin (-\theta + \delta + \beta) \quad \ldots\ldots (3)$$

Now, denoting by a and b the parts into which the link AB is divided, it will be clear that

the resultant motion of H will partake partly of that due to A and partly of that due to B, and that the fractional part due to each will vary inversely as the distance of H from the two ends. That is, the fraction $a \div (a + b)$ will come from B, and the fraction $b \div (a + b)$ will come from A. Again, while the motion of A due to P, as given by the equation above, is, strictly speaking, to be estimated along OA, yet, since in practice the angle α is small, the error in taking this as the equivalent of the motion along, or in the direction of OH will be very small and may be accepted for the sake of the simplification which it will bring. Similarly for the motion of B along OB, and we therefore have for the two fractions of the motion of H along OH the relative values given above. Hence, calling y the total motion, we have:

$$y = \frac{b}{l} r \sin(\theta + \delta + \alpha) + \frac{a}{l} r \sin(-\theta + \delta + \beta) \quad \ldots\ldots (4)$$

If we expand the values of $\sin(\theta + \delta + \alpha)$ and $\sin(\delta + \beta - \theta)$, we shall have the following expressions:

$$\text{Sin } \delta \cos \alpha \cos \theta + \cos \delta \sin \alpha \cos \theta + \cos \delta \cos \alpha \sin \theta - \sin \delta \sin \alpha \sin \theta$$
$$\text{Sin } \delta \cos \beta \cos \theta + \cos \delta \sin \beta \cos \theta - \cos \delta \cos \beta \sin \theta + \sin \delta \sin \beta \sin \theta$$

Since α and β are very small angles, we may, without serious error, substitute 1 for both $\cos \alpha$ and $\cos \beta$, and also $a \div OA$ or $a \div g$ for $\sin \alpha$, and similarly $b \div g$ for $\sin \beta$. Making these substitutions, we find for the two expressions:

$$\frac{br}{l}\left(\sin \delta \cos \theta + \frac{a}{g} \cos \delta \cos \theta + \cos \delta \sin \theta - \frac{a}{g} \sin \delta \sin \theta\right)$$
$$\frac{ar}{l}\left(\sin \delta \cos \theta + \frac{b}{g} \cos \delta \cos \theta - \cos \delta \sin \theta + \frac{b}{g} \sin \delta \sin \theta\right)$$

Adding these we have:

$$y = \left(\frac{(b - a)}{l} r \cos \delta\right) \sin \theta + \left(r \sin \delta + \frac{2abr}{gl} \cos \delta\right) \cos \theta \quad \ldots\ldots (5)$$

Now denoting the coefficient of $\sin \theta$ by P and that of $\cos \theta$ by Q, we have:

$$y = P \sin \theta + Q \cos \theta \quad \ldots\ldots (6)$$

It will be noted that the coefficients P and Q depend solely on the dimensions and proportions of the gear, and are independent of the angle θ. Comparing these with [4] (3), it will be seen that it is in the same general form as that derived for the movement of a simple eccentric. This is a most important fact and its significance should be carefully noted by the student. It means that for any adjustment of a Stephenson link there is some single eccentric which would produce substantially the same motion. The throw and angular advance of this equivalent single eccentric would not, of course, be that of the eccentrics P and Q of the gear. We must therefore determine what this throw and angular advance are, and how they are related to the various dimensions and adjustments of the actual gear. Referring again to equations [4] (5) (6), it is seen, where P and Q are the coefficients of $\sin \theta$ and $\cos \theta$ respectively in the expression for the valve movement, that the throw and angular advance of the eccentric are determined as follows:

$$r = \sqrt{P^2 + Q^2}$$
$$\tan \delta = \frac{Q}{P}$$

If, therefore, we denote by r_0 and δ_0 the throw and angular advance of the equivalent or virtual eccentric for the Stephenson link, we shall have similarly:

$$r_0 = \sqrt{P^2 + Q^2}$$
$$\tan \delta_0 = \frac{Q}{P}$$

where P and Q denote in equation (6) the coefficients of $\sin \theta$ and $\cos \theta$ respectively.

It appears further, as a graphical construction, that we could construct r_0 by laying off P and Q as the two sides of a right-angled triangle, as illustrated in Fig. 21.

Now, taking the expressions for P and Q as follows:

$$P = \frac{(b-a)}{l} r \cos \delta$$
$$Q = \left(r \sin \delta + \frac{2abr}{gl} \cos \delta\right)$$

it is seen that, outside of the fixed dimensions of the gear, the only quantities involved are the parts a and b of the link AB, and that the variation in these means simply a change in the location of the link block H between the ends A and B.

If now we suppose that the link block H is made to occupy all possible locations between A and B, and that the corresponding values of P and Q are found and laid off as the two sides of a right-angled triangle, starting from a fixed point, as O in Fig. 21, then it is clear that the outer ends of this hypothenuse, representing by its length and angular position the length r_0 and angular advance δ_0, will lie on a curve somewhat as indicated in Fig. 22. This curve will be in effect the locus of the outer end of the virtual eccentric throw, and lines drawn from O to this curve will represent in angular advance and throw all possible values of r_0 and δ_0 corresponding to varying adjustments of the gear as regards the position of the link block.

It may be further noted that of these values P and Q, the former will decrease and the latter will increase as the block is brought from the end toward the center of the link, thus giving a curve of the general character shown in Fig. 22.

We may next note that where the block is at the end of the link, $a = 0$ and $b = l$. Hence we have $P = r \cos \delta$ and $Q = r \sin \delta$. This shows, as we should expect, that in this condition the virtual eccentric becomes the real eccentric. Again, when the block is in the middle of the link, $b = a = l \div 2$, and we have

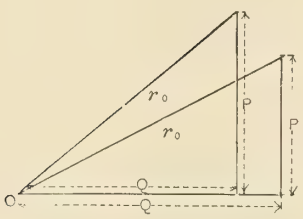


FIG. 21.

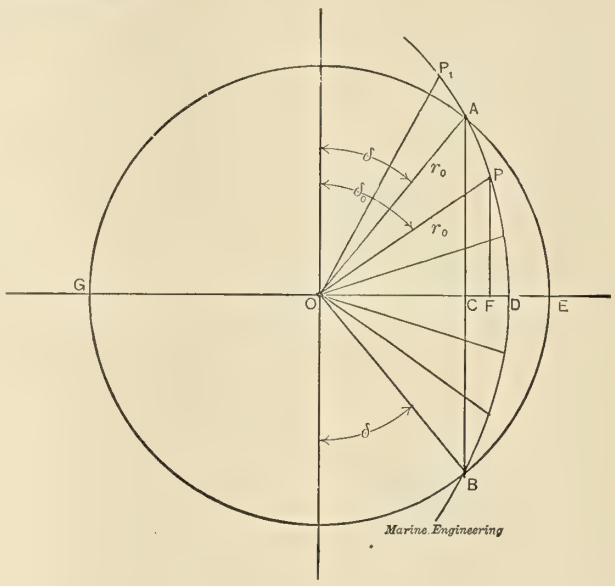


FIG. 22.

$$P = 0 \text{ and } Q = \left(r \sin \delta + \frac{2a^2}{gl} r \cos \delta\right) = \left(r \sin \delta + \frac{l}{2g} r \cos \delta\right)$$

Referring to Fig. 22, it is seen that $OC = r \sin \delta$, and hence the distance CD will be measured by $\frac{l}{2g} r \cos \delta$, thus making up for OD the total value of Q as expressed above.

Now, it is found by experience that if the point D is thus located and a circular arc is then struck through A, D, and B, the curve ADB thus resulting is a very close approximation to the actual curve determined in detail, as explained above.

It will be of interest, however, to ascertain the character of the curve ADB, and this may be easily done as follows:

Counting from O as origin, denote the value of P by y and that of Q by x. Then we have as the co-ordinates of the curve:

$$y = \left(\frac{b - a}{l}\right) r \cos \delta$$

$$x = r \sin \delta + \frac{2abr}{gl} \cos \delta$$

Now, suppose that $a = el$, where e is a certain percentage or ratio. Then $(b - a) \div l = (1 - 2e)$ and $ab \div l = e\ (1 - e)\ l$.

Substituting we have:

$$y = (1 - 2e)\, r \cos \delta$$

$$x = r \sin \delta + \frac{2e\ (1 - e)\ l}{g} r \cos \delta$$

Now, to find the equation to the curve in terms of x and y as co-ordinates, we have only to eliminate e between these two equations. By ordinary algebraic processes this leads to the following equation:

$$x = -\frac{l}{2gr\cos\delta}y^2 + \left(r\sin\delta + \frac{l}{2g}r\cos\delta\right)$$

It may be readily seen by the usual tests of analytical geometry that this is the equation to a parabola with general form as shown in Fig. 22 and passing through the three points A, D, B determined as described above.

The use of the circular arc passing through these same three points is then justified by the fact that the actual test shows the circle to lie very close to the parabola and to practically replace it for all ordinary uses. A like test further shows that for all practical purposes the curve ADB may be considered as a miniature of the link, and that the virtual eccentric for various positions of the block in the actual link may be determined with all necessary accuracy by locating a point such as P, Fig. 22, at a corresponding point on the curve, and drawing the line OP to such point. This is equivalent to assuming that any point P on the curve ADB will represent with sufficient accuracy the location of the block in the link itself, and that as the actual link is hooked up to various positions the operation may be represented and the virtual eccentric determined by supposing a point P to move similarly on the curve, and by drawing a series of radii to such points.

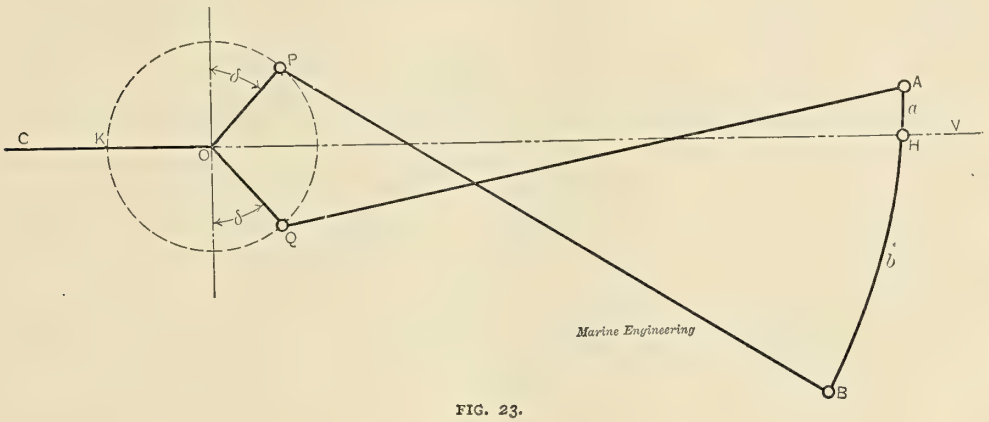


FIG. 23.

In some cases the link overruns at the end, and the block passes outside the point of attachment to the eccentric rod. This is represented by a point P_1 on the curve extended beyond A and B as shown. Actual test here also shows that such an adjustment of the link may be thus represented, and that the virtual eccentric may be represented by drawing a line as OP_1 to the point in question.

The arrangement of Fig. 20 shows the eccentric rods open when the crank C is turned away from the cylinder. In Fig. 23 is shown in similar outline the arrangement with rods crossed when the crank is turned from the cylinder. The former arrangement is known as the "open-rod" and the latter as the "crossed-rod." An investigation of the resulting movement would show that it was similar with certain changes of algebraic sign, and as a consequence of which the curve of virtual eccentrics is turned the other way, as shown in Fig. 24.

To find the locus of the other ends of the virtual eccentric throws for any arrangement of Stephenson link, we have therefore the following simple steps:

(1) Lay off the actual eccentrics, as at A and B, Fig. 22 or 24, and draw the lines OE and AB.

(2) Find the fraction $l \div 2g$ of the distance AC and lay it off as the distance CD, thus fixing D to the right or left, as the gear is open-rod or crossed-rod.

(3) Find by trial the center of a circular arc which will pass through ADB, and describe such arc, which will be the locus desired.

This will serve to determine the characteristics of the virtual eccentric for any adjustment of the gear, and hence, by the application of some one of the preceding simple constructions, all questions regarding the characteristics of the valve movement may be determined.

By reference to Fig. 22 and to the construction for the Zeuner diagram, it will be clear that with the open-rod form, as the gear is linked up, the virtual angular advance increases,

the virtual throw, valve travel, and port opening decrease, the lead increases, and the cut-off becomes earlier.

For the crossed-rod form the changes are of the same general character, except in the lead, which decreases as the gear is linked up.

The chief point of difference in the two forms of gear is seen to be in the lead, which increases with open-rods and decreases with crossed-rods as the gear is linked up. While both forms of gear are met with, the open-rod type is the more frequently employed. This is due to the fact that as the cut-off is made earlier by linking up, an increase of lead is usually preferable to a decrease, and also to the fact that the width of port opening is decreased less rapidly by the open than by the crossed gear.

Again, it is readily seen that as the point *P* passes the middle of the curve and goes to the other side, or, in the actual gear, the link block passes the center of the link and goes toward the other end, the same series of changes with either form of gear will be traversed.

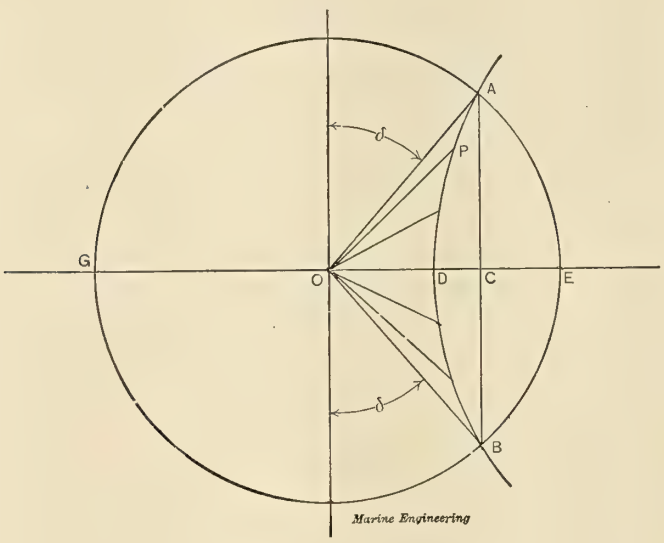


FIG. 24.

and in the opposite direction, ending with a virtual throw and angular advance equal to that of the actual eccentric at the other end of the link *B*. It will be clear, from what has been said in connection with the simple valve gear regarding the direction of rotation, that all locations of *P* between the end *A* and the middle will correspond to rotation in one direction or with an outside valve from *C* toward *A*, while all locations of *P* between the end *B* and the middle will correspond to rotation in the other direction, or from *C* toward *B*.

The application of the Stephenson link as a reversing gear is thus shown, as well as the gradual way in which this is brought about by a continuous change in the characteristics of the virtual eccentric, bringing about changes in the steam distribution as noted above.

The principal characteristics of these two types of Stephenson link valve gear with regard to the effect on the various events, etc., due to linking up the gear, may be conveniently presented in the following tabular form:

STEPHENSON LINK.

EFFECT OF LINKING UP.

Type of gear	Open-rod.	Crossed-rod.
Virtual eccentric throw	Decreased.	Decreased.
Virtual angular advance	Increased.	Increased.
Valve travel	Decreased.	Decreased.
Port opening	Decreased.	Decreased.
Lead	Increased.	Decreased.
Cut-off	Earlier.	Earlier.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports under date of December 9, 1903, the following construction of vessels for the United States Navy:

				DEGREE OF COMPLETION.	
				November 1.	December 1.
BATTLESHIPS.					
No. 11..	Missouri	18 knots	Newport News Co	99 per cent.	99 per cent.
" 12..	Ohio	18 "	Union Iron Works	82 "	83 "
" 13..	Virginia	19 "	Newport News Co	47 "	50 "
" 14..	Nebraska	19 "	Moran Brothers Co	30 "	30 "
" 15..	Georgia	19 "	Bath Iron Works	37 "	40 "
" 16..	New Jersey	19 "	Fore River S. and E. Co.	46 "	48 "
" 17..	Rhode Island	19 "	Fore River S. and E. Co	47 "	48 "
" 18..	Connecticut	18 "	Navy Yard, New York, N. Y	21 "	24 "
" 19..	Louisiana	18 "	Newport News Co	28 "	31 "
" 20..	Vermont	18 "	Fore River S. and E. Co	0 "	1 "
" 21..	Kansas	18 "	New York Shipbuilding Company	5 "	2 "
" 22 .	Minnesota	18 "	Newport News Co	4 "	8 "
ARMORED CRUISERS.					
No. 4..	Pennsylvania	22 knots	William Cramp and Sons	60 "	63 "
" 5..	West Virginia	22 "	Newport News Co	64 "	67 "
" 6.	California	22 "	Union Iron Works.	43 "	48 "
" 7..	Colorado	22 "	William Cramp and Sons	65 "	67 "
" 8..	Maryland	22 "	Newport News Co	60 "	63 "
" 9..	South Dakota	22 "	Union Iron Works	41 "	44 "
" 10..	Tennessee.	22 "	William Cramp and Sons	10 "	12 "
" 11..	Washington	22 "	New York S. B. Co	8 "	9 "
PROTECTED CRUISERS.					
No. 14..	Denver	17 knots	Neafie and Levy	98 "	98 "
" 15..	Des Moines	17 "	Fore River S. and E. Co	94 "	96 "
" 16..	Chattanooga	17 "	Lewis Nixon	74 "	72 "
" 17..	Galveston	17 "	Wm. R. Trigg Co	68 "	69 "
" 18 .	Tacoma	17 "	Union Iron Works	93 "	96 "
" 20..	St. Louis	22 "	Neafie and Levy	32 "	34 "
" 21 .	Milwaukee	22 "	Union Iron Works	35 "	38 "
" 22.	Charleston	22 "	Newport News Co	53 "	55 "
GUNBOATS.					
No. 17..	Dubuque	12 knots	Gas Engine and Power Co	10 "	15 "
" 18..	Paducah	12 "	Gas Engine and Power Co	9 "	13 "
TRAINING SHIPS.					
.. ..	Cumberland	Sails	Navy Yard, Boston	0 "	7 "
.....	Intrepid	"	Navy Yard, Mare Island	0 "	0 "
TRAINING BRIG.					
....	Boxer	Sails	Navy Yard, Portsmouth	2 "	3 "
TORPEDO BOATS.					
No. 19..	Stringham	30 knots	Harlan and Hollingsworth	95 "	93 "
" 20..	Goldsborough.	30 "	Wolff and Zwicker	99 "	99 "
" 27..	Blakely..	26 "	George Lawley and Son..	99 "	99 "
" 29..	Nicholson	26 "	Lewis Nixon	99 "	99 "
" 30..	O'Brien	26 "	Lewis Nixon	98 "	98 "
" 34..	Tingey	26 "	Columbian Iron Works	97 "	100 "
STEEL TUGS.					
No. 8..	Pentucket	12 knots	Navy Yard, Boston.	90 "	96 "
" 9	Sotoyomo	12 "	Navy Yard, Mare Island	90 "	95 "

ENGINEERING SPECIALTIES.

Electric Steering Gear.

New uses of electricity on shipboard are constantly being found, as described elsewhere in these pages. The application of electricity to steering gear is most recent because of the more or less complicated form of controller which up to date has been required. Herewith is presented and illustrated an electric steering gear patented by Mr. Brougham and installed on the English yacht *Valhalla*.

The mechanical operation is of the type usually fitted on large yachts for hand steering, and has only been slightly altered to allow of electric controller. It consists essentially of a solid cast-iron frame bolted to the deck. The upper end of the rudder post passes through the base of the frame and carries, securely keyed to it, a massive crosspiece, above which and running fore and aft is a right- and left-handed screw supported by the frame and carrying one right- and one left-handed nut, as shown in the engraving. These nuts are supported and prevented from turning by two guides running parallel with the screw, and are connected by links, one to each side of the crosspiece on the rudder post. By this means the turning of the screw operates the rudder. The steering wheel is large enough to be used in emergency for hand steering. It is carried on a sleeve on an extension of the screw, to which it can be connected by means of a claw clutch.

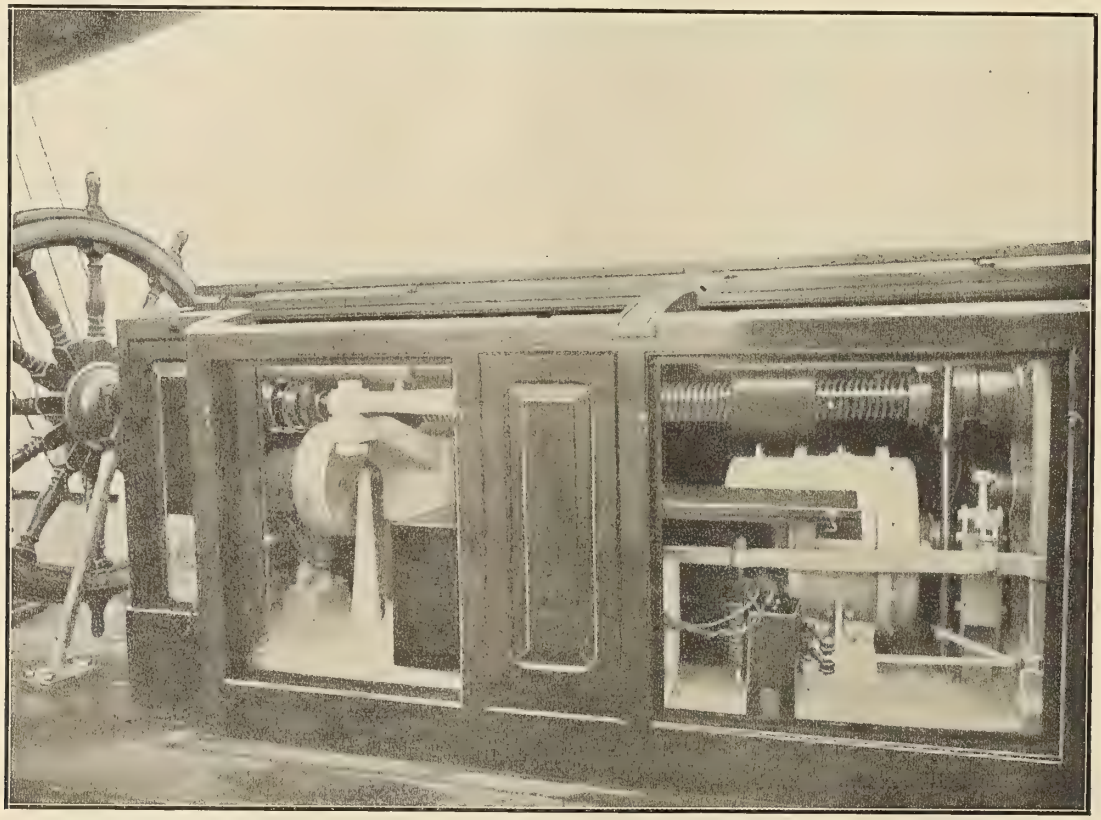
A Siemens 4-pole motor, completely enclosed, is

arranged to drive the screw through several reductions of spur gearing and a claw clutch, which is connected to the clutch on the steering wheel in such a manner that both are operated by one lever and only one can be in gear at a time. It will thus be seen that the screw, which operates the rudder through the nuts and links, may be turned either way by the electric motor or by the steering wheel, but not by both at the same time. The motor is series wound and is provided with a brake pulley and brake blocks which are held off by an electromagnet in series with the motor and held on by a suitable spring. The brake is therefore put on and the motor promptly pulled up whenever the current is interrupted.

The motor is controlled by a special hunting switch with two levers and two sets of contacts, one for each direction of rotation. This arrangement was adopted instead of a single reversing switch in order to get a very reliable quick break action. Each switch has three contacts, so that resistance can be cut out in two steps, and they are so shaped that the actual contact surfaces are not touched by the arcs and therefore remain in good condition. They are reversible and can be easily replaced, the insertion of new ones occupying but a very few minutes. A powerful magnetic blow-out, which operates upon all the contacts, is provided on each switch. Ample precautions against arcing troubles have been taken because of the extremely frequent switching off and on which is required in the ordinary steering of a ship.

The two switch arms are mounted on two pins at equal distances from the center of a metal disk geared to the steering wheel. The second disk is in gear with the screw and its motion is therefore proportional to that of the rudder. The switching on or off is therefore the result of the difference in the motions of the two disks, which are proportional to that of the rudder and the steering wheel respectively.

The gearing is such that twelve complete turns of the steering wheel move the rudder from hard-a-port to hard-a-starboard, a total angular distance of 80 degrees. A Geneva stop, in connection with the second disk prevents the steering wheel from turning more than twelve complete revolutions, and when the second disk is brought to rest by the stop the first catches it up. The motor is thus automatically switched off when the extreme positions of the rudder are reached.



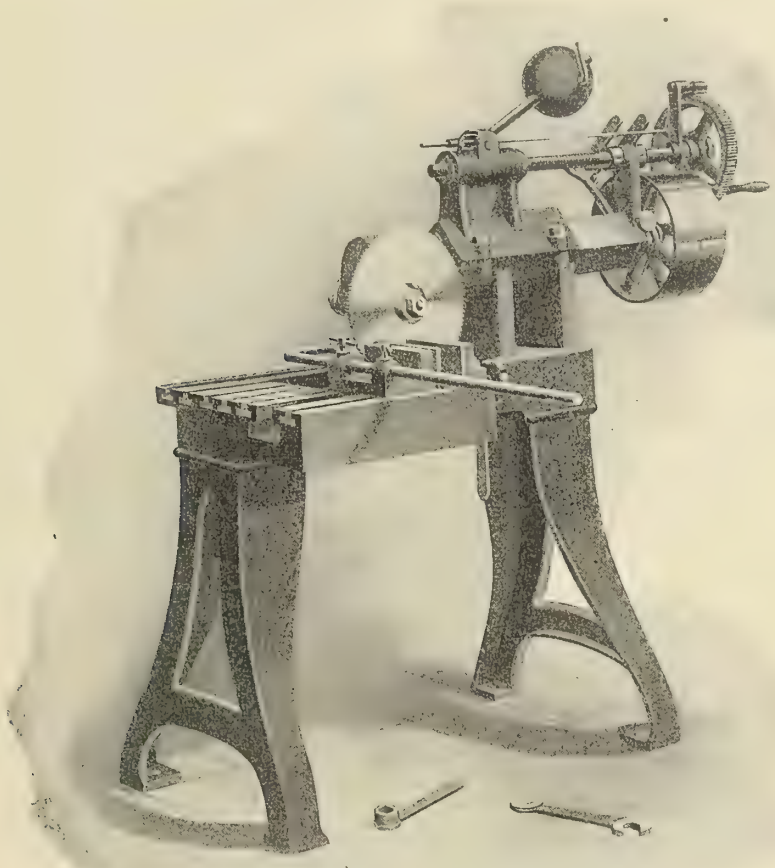
ELECTRIC STEERING GEAR ON THE YACHT VALHALLA.

The gear on board the *Valhalla* is stated to have amply proved its efficiency, and given complete satisfaction to the navigating officers, the control of the ship being as perfect as could be desired. The test imposed, which was considered the most severe, namely, throwing the rudder from hard-a-port to hard-a-starboard whilst steaming full speed astern, was accomplished with ease and without excessive consumption of current. When steered by hand the gear requires the combined energies of four or more men, according to the state of the weather.

Complete particulars of this gear may be had by addressing the manufacturers, Siemens Brothers and Company, Limited, 12 Queen Ann's Gate, Westminster, London, S. W.

Cold Saw Cutting-Off Machine.

The accompanying illustration shows one size and style of the Wagner cold saw cutting-off machine, made by the Diamond Drill and Machine Company, Birdsboro, Pa. The machine is next to the smallest size and carries a blade 12 inches in diameter. The saw is mounted in an arbor that is carried in a swivel head secured to the front of the ram. This ram is square in section and travels in a long, rigid guide. The head is graduated and can be swung clear around in a vertical plane and clamped in any position, thus making it possible to cut off the stock at any desired angle. The arbor is driven by means of a phosphor-bronze worm wheel and steel worm, the worm shaft running longitudinally through the ram and carrying on its end tight and loose driving pulleys, thus requiring no counter-shaft.



COLD SAW CUTTING-OFF MACHINE.

The feed is positive and is obtained by means of an eccentric on the end of the worm shaft. The feed screw is journaled in a bracket at the end of the ram and runs through a nut which fits freely in a bracket cast on the top of the ram guide. The screw is rotated by a ratchet wheel and pawl. A rack is formed at the top of the feed nut, and meshing with this rack is a pinion to which is attached an arm carrying an adjustable weight. This arrangement makes a very sensitive feed; it is easily regulated by shifting the weight, and when the saw becomes dull and does not cut freely, or the cross section increases, the weighted arm lifts, releases the feed, and prevents the saw breaking or becoming jammed.

A pan is formed in the table for soap water or other lubricant, in which the saw constantly dips. The 12-inch saw will cut rounds up to 3 1-2 inches in diameter. The largest machine, carrying a 40-inch blade, will cut rounds up to 13 inches in diameter. These machines are built with seven sizes of saw blades, and as many as four different styles of bed plates and vises with each style of saw blade. A special study has been made of designing different styles to meet the varying requirements to which this unique cold saw cutting machine can be put. The machine for cutting long I-beams, channels, or heavy shafts is so designed that it is not necessary to turn the work around when it is desired to cut off both ends.

Some of the advantages claimed for this machine are: great capacity for speed, minimum wear of saw blade, automatic feed according to variation in shape or hardness of material to be cut; no cessation in cutting, even in case of saws with teeth broken out, etc. It is automatically thrown out of feed when the cut is completed, thus allowing one operator to have charge of several machines.

Water-Tube Boiler.

The four recently-constructed monitors for the United States Navy are each fitted with a different type of water-tube boiler, which is practically the only point of difference, the Mosher boiler being installed on the *Florida*. A comparison of trial results speaks most favorably for this boiler, both in steaming capacity or heating surface and light weight.

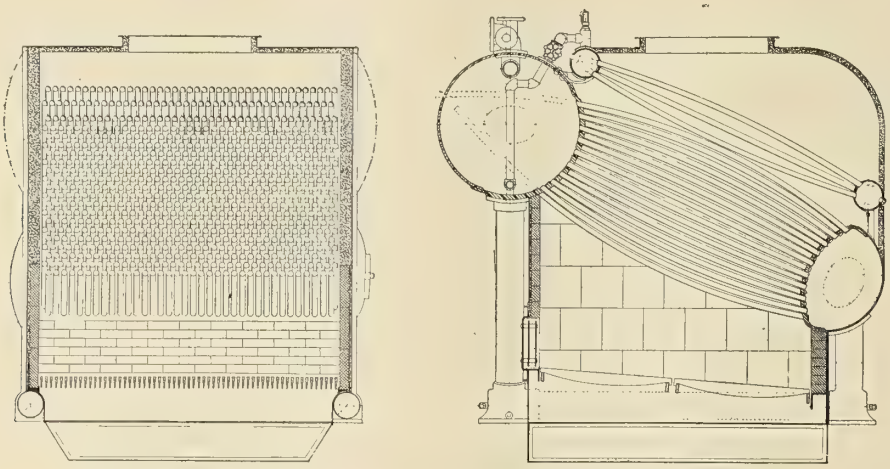
The Mosher boiler consists of four elements, viz.: steam drum, water drum, tubes, and return pipes. These different parts may be seen by referring to the cut. The steam drum is supported at each end by a large return or circulating pipe, with the necessary fittings. The fittings at the bottom are provided with handholes in the front, and at the back two circulating pipes extend forward with the necessary connections for supporting the water drums. The tubes are expanded directly into the steam and water drums and may be conveniently reached for expanding through manholes in the heads of the drums. The tubes are given a slight curve and by the dotted lines it will be seen may be cleaned, withdrawn, or replaced through a single row of handholes in the front portion of the steam drum. As many as five vertical rows, or 45 tubes, may be cleaned, withdrawn, or replaced by removing one handhole cover.

The feed-water heater consists of two steel drums connected by slightly curved tubes which are expanded into them. These drums are fitted with a row of handholes similar to the steam drum of the boiler and are placed out of the path of the gases of combustion, thus preventing the possibility of injury regardless of the amount of scale or sediment that may collect in them. The handholes of boiler and heater are closed by a special plug or cover, which consists of a conical-headed bolt provided with a short piece of copper tube, a washer and nut. The head of the bolt and copper tube may be inserted in the opening (or handhole) from the outside of the drum, after which the nut may be screwed up, thereby flaring the end of the copper tube by drawing the conical head of the bolt into the same, thus forming a steam-tight metallic joint, the pressure always being on the head of the bolt, thereby increasing the tightness of the joint.

These boilers are constructed in standard sizes up to 2,500 square feet of heating surface, and larger sizes to meet any special requirements. The standard boilers are fitted with cast-iron grate bars, but wrought-iron bars may be fitted when required for special service.

By referring to the drawing it will be seen there are no baffles provided for distributing the gases of combustion. This is accomplished by special means in a far more effective manner. The great objection to the usual baffles is well known, as they make it practically impossible to clean the tubes, besides providing shelves or pockets for soot and ashes to collect on, and further they cause the gases to take a diagonal course over the tubes, thus failing to sweep over a large portion of their surface.

Due to structural conditions in most other boilers, and particularly those constructed with headers, it is necessary to space the tubes so far apart that baffles must be used to prevent the gases from taking a direct course to the stack, which would cause a sacrifice of the effective heating surface. Furthermore, if the tubes are spaced a considerable distance apart, they not only allow the gases to pass by without coming in contact with the upper third of their surface, but soot and ashes collect on this surface undisturbed by the gases. In the Mosher boiler most of the tubes are spaced so close together that each tube acts as a baffle for the tube below it and effectually distributes the gases over the entire surface of the tubes, keeping all the tubes swept free from ashes and soot, and thus allowing the full capacity of the boiler to be realized. It is impossible to place the tubes as close together as desired for the purpose of reducing the space between them to approximate that of the stack; the gases therefore would have some tendency to take a direct course to the stack and not pass over the tubes at the end and corner portions of the furnace. This is effectually overcome by the Mosher patent feed-water heater, which, as it is made with small size drums, permits the tubes to be placed sufficiently close together so as to reduce the calorimeter to slightly over that of the stack. As will be seen by referring to the drawing, this heater extends the whole length of the tubes, which it is claimed obliges the gases, in order to

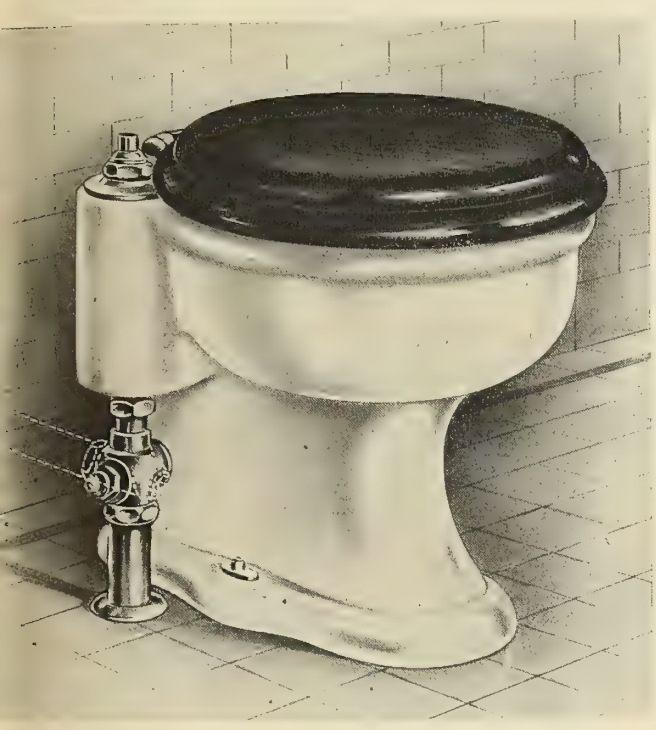


FRONT AND SIDE SECTIONAL ELEVATIONS OF MOSHER WATER-TUBE BOILER.

realize sufficient area for egress from the boiler, to be distributed over all the surface of the generating tubes as well as that of the heater itself.

Another advantage resulting from placing the tubes staggered and close together is that the gases in passing by are "broken up" by them and the maximum amount of heat is transmitted to the heating surfaces.

This boiler is made by the Mosher Water Tube Boiler Company, 1 Broadway, New York, N. Y.



CLOSET WITH SPECIAL COMPACT VALVE.

The Auto Closet.

The accompanying cut is that of a new type of water-closet called the Auto, which is particularly well adapted for use on board steamships because of its compactness, and because it is practically indestructible and dispenses with the individual supply tanks. The valve used to operate this closet is a special form of the Watrous Aquameter, which is now in general use. The valve is entirely closed within the earthenware, which renders it impossible to be tampered with and reduces the amount of nickel-plated work to be taken care of. The closet bowl is of a very heavy siphon-jet pattern and can be operated by direct pipe connection from the supply tank or automatic pump, whichever system may be employed for supplying the water.

For salt-water use the valve is made with glass-lined body, so that no corrosion occurs. A number of these closets, which are made by the Federal Company of Chicago, have been used in marine work by shipbuilders on the lakes and coast.

Resumed Work.—The Townsend-Downey Shipbuilding Company, Mariners' Harbor, N. Y., which went into the hands of a receiver early in December, owing, it is stated, to labor troubles, has resumed work.

QUERIES AND ANSWERS.

Q. 181.—Will you kindly answer the following questions in your valuable inquiry column?

(a) How would you know how to power a yacht like the *Corsair* if you wanted her to make about 20 knots per hour?

(b) Are there any rules in figuring out overhangs, breadth, and draft of such a yacht? W. J. E.

A.—*(a)* There is no rule-of-thumb method for powering, and to decide correctly upon the horse power required to drive the *Corsair* at 20 knots it would be necessary to have full information concerning the lines of this boat, and to be pretty well posted in the performance of other similar vessels; for there are no definite rules, and most of the figuring has to be decided by comparing with other known vessels. The simplest rule is expressed in the following formula:

$$\text{I.H.P.} = \frac{D^{\frac{2}{3}} S^3}{C}$$

in which D = displacement; S = speed in knots; C = constant, which for this class of vessel might be taken in the neighborhood of 200.

The general dimensions of the *Corsair* are: length on water line, 272 feet; breadth, 33 feet 3 inches; depth, 20 feet 6 inches; and draft, 15 feet 10 inches. We do not know the displacement, but can assume it at 2,500 tons. The square of the displacement will then be 6,250,000, and the cube root of this will be 184.2. You have given 20 knots as the desired speed; the cube of this is 8,000; substituting, then, in the above formula, we have:

$$\text{I.H.P.} = \frac{184.2 \times 8{,}000}{200} = 7{,}368$$

(b) There are no definite rules for determining on the overhang, breadth, and draft, but these dimensions vary with the different designers and the service for which the yacht is intended. The *Corsair* represents the Watson design, which is considered the highest type for yachts. The draft will be determined by the service for which the yacht is intended.

Both of these subjects are treated in different books published.

Q. 182.—A tugboat engine is of the following description: vertical inverted, single cylinder of 20 inches diameter of piston and 22 inches stroke; link motion with a piston valve; boiler allowed 110 pounds steam; vacuum 25 inches; cut-off on link at about one-half stroke with one-half turn on throttle valve (globe valve) will make from 95 to 100 revolutions per minute with a tow and uses all the steam the boiler can make with natural draft. The boiler is of the marine-leg, fire-box type, with two furnaces. Length of boiler, 14 feet; width or diameter of boiler, 8 feet; furnaces, 39 inches wide by 6 feet 6 inches; two flues 14 inches and four of 11 1-2 inches, all 4 feet 2 inches long; eighty-three 3 3-4-inch tubes; diameter of main steam pipe, 5 inches; temperature feed water with heater, about 125 degrees.

Would it be a good idea to replace this old engine with a steeple compound of the same stroke? That is, would the boiler steam any better for a smaller cylinder used as a high-pressure, and could steam be kept up with a wide-open throttle? Also, would there be any increase in the number of revolutions? About what size of cylinder would be right, and how would you figure it out to find the right dimensions for a new engine? W. E. S.

A.—To answer this question it is first necessary to figure out the heating surface of your boiler, which we can only approximate, as we are not absolutely sure of the type used. That is, your tubes are 11 feet 6 inches, while the length of flues in furnaces added together

makes but 10 feet 8 inches. The approximate figures for the heating surfaces of them are as follows:

	Square feet.
Furnace	125
8 flues	114
83 tubes	880
Total	1,119

This boiler should have sufficient steam for about a 250-I. H. P. engine at the rate of 4 1-2 square feet per I. H. P. You doubtless would find very much better results by installing a steeple compound, for the cubic capacity of steam to the point of cut-off in your old engine is about 3,450 cubic inches outside the clearance, and the mean effective pressure of the old engine running at 150 horse power is 74 pounds.

Using the same stroke, 22 inches, we find the area of the low-pressure cylinder by formula, as follows:

$$A = \frac{\text{I. H. P.} \times 33{,}000}{P \times L \times N}$$

where A = area cylinder in square inches.
I. H. P. = horse power = 250 in this case
P = mean effective pressure, which we will assume as 40 pounds for this case
L = length of stroke in feet
N = number of strokes, or 95 × 2
33,000 = a constant

$$\text{Then } A = \frac{250 \times 33{,}000}{40 \times 1.88 \times 95 \times 2} = 578 \text{ square inches.}$$

This from the table of areas we find equivalent to a circle of about 27 1-8 inches diameter. Therefore we may assume the low-pressure cylinder to be 27 inches.

Under these conditions a cylinder of 14 inches diameter would be appropriate for the high-pressure, so that we have an engine 14 and 27 inches by 22 inches. The cubic capacity in this cylinder, up to the point of cut-off, which we would now assume to be about 64 per cent., or 14 inches, will be 2,142 cubic inches, or less than two-thirds the volume up to point of cut-off of your old engine. The same amount of work is obtained by increased efficiency through the increased number of expansions. If this engine were installed you would doubtless have no trouble in keeping up your steam pressure with throttle full open and increase the revolutions.

Q. 185.—Which vessel will stand the most air pressure per square inch—a spherical one 1 foot in diameter, or one 2 feet in diameter, each of them made of the same thickness of the same material?

A.—The smaller vessel will stand the greatest pressure, and in the case above it will stand twice the pressure per square inch that the larger one will. Consider a hollow sphere and draw a line upon it dividing it in halves. The bursting pressure at all points of the sphere is the same, and we may learn about it by examining the conditions that exist along this line of division. Now, if the inside is subjected to an air pressure, the tendency will be to stretch and rupture the shell, and the total bursting pressure along the circumferential line will be equivalent to the pressure per square inch, times the effective area, and this effective area equals the area of a circle of the same diameter as the sphere. With a sphere 1 foot in diameter the area will be .7854 square foot, or 113.10 square inches; so that if a pressure of 100 pounds per square inch were applied, then the total bursting pressure would be 11,310 pounds. Now, this pressure is equally distributed at all points of the circumferential line on the shell. As the circumference of the sphere is 3.1416 feet, or 37.7 inches, for each inch of circumferential length there is a stress on the shell of 300 pounds.

Now assume a second cylinder, 2 feet in diameter, similarly placed and divided as the first one, and that the same pressure, or 100 pounds per square inch, be applied on the inside. The total bursting pressure will then be equivalent to the area of the circle whose diameter is 24 inches times 100 pounds, or 452.39 × 100 = 45,239 pounds total. Similarly this lifting pressure is distributed over the total circumference of the sphere, and as the circumference is 2 × 3.1416, or 6.2832 feet, or 75.4 inches, the upward pressure per linear inch is 600 pounds, which is twice as great as the pressure on the smaller sphere.

Thus by applying the same pressure per square inch to each sphere, the resulting bursting pressure in the larger one is twice that of the smaller one, or, in other words, only half the pressure per square inch may be applied to the two-foot sphere as to the one-foot sphere to produce the same bursting pressure.

Q. 186.—I would like to know if I will have to become naturalized before I can get a marine engineer's license. I was born in New Brunswick and moved to Massachusetts when I was 3 years old and have lived there ever since, being 22 years now. My father took out his naturalization papers right after we moved to Massachusetts. C. J. T.

A.—Only citizens of the United States are eligible for examinations for marine engineer's license. Under the laws of naturalization, if the father takes out naturalization papers before the son is eighteen years of age, the son becomes a citizen of the United States. So, as your father took out such papers when you were a boy, you are legally considered a citizen of the United States and are therefore eligible for examination.

Q. 187.—I wish you would settle the following point. In your July number you have the supplement of a 3-cylinder, direct-acting, triple-expansion engine. M. J. says that the piston designed like that high pressure has more area than a piston of the old style and more power for its size. I say that it has no more power than the old style, although it has more sectional area. I claim that the new area makes for strength and lightness. Please set us right. E. O. M.

A.—You are right and M. J. is wrong. The power of an engine depends on four factors: first, length of stroke; second, pressure on the piston; third, number of strokes; and fourth, the area of the piston. By the area of the piston is meant the projected area, or that equivalent to a flat piston, and the thickness and shape of the piston have nothing whatever to do with the power. The cone shape is used because it makes a very strong piston.

For finding the I. H. P. of an engine use the following formula.

$$\text{I. H. P.} = \frac{P \times L \times A \times N}{33{,}000}$$

The meaning of the terms is given in the answer 182.

Q. 188.—Kindly publish through your paper the following: What would be the horse power of a cross-compound engine, 11 1-8 inches high-pressure and 24 1-2 inches low-pressure, with a common stroke of 4 feet 8 inches, making 24 revolutions, boiler pressure 150 pounds, 5-8 cut-off on high-pressure cylinder and working full stroke on low-pressure cylinder, 3-4-inch clearance in cylinders, rods 2 1-4 inches and 2 3-4 inches? This arrangement is to be worked on a western river steamboat, engines condens-

ing. An approximate calculation will do. Would also like to have any suggestion you may see fit to make. What will be the difference in horse power developed in each cylinder?

PITTSBURG.

A.—By making certain assumptions the answer to this question may be found similarly to that in Q. 182, or by using other formula the following solution may be carried out:

Cutting off at 5-8 stroke in the high-pressure cylinder and expanding to full low-pressure cylinder gives a total number of expansions of 7 3-4; this is found as follows: By dividing the cubic capacity of the low-pressure cylinder by the capacity of the high-pressure up to the point of cut-off. In other words,

$$\frac{471.4 \text{ sq. ins.} \times 56 \text{ ins. (stroke)}}{96.8 \text{ sq. ins.} \times 56 \text{ ins.} \times 5\text{-}8} = 7.73, \text{ say } 7\ 3\text{-}4.$$

With gauge pressure of 150 pounds at boiler, that at engine valve would be about 143 pounds. Then the mean effective pressure, P, for this ratio of expansion, $r = 7.75$, is solved from the formula

$$P = p_1 \frac{1 + \text{hyp. log } r}{r}$$

where p_1 = the absolute initial pressure, which in this case is 143 + 14.7 pounds = 147.7 pounds, say 158.

The expression at the right is found from tables given in practically all steam engineering books to be .3939, and substituting, $P = 158 \times .3939 = 62.2$ pounds.

Thus, if the full theoretical power of the steam expanding from the initial pressure down to a vacuum were available, the mean effective pressure reduced to the low-pressure cylinder would equal 62.2 pounds. Because of condensation, compression, dividing into two cylinders, etc., the actual pressure is only a certain percentage of this, the per cent. being called the card factor. With your engine the factor .68 would be about right, which would give a value of 42.3 pounds. From this the I. H. P. may be found from the usual formula:

$$\text{I. H. P.} = \frac{P \times L \times A \times N}{33{,}000}$$

Substituting for these values in the above formula we have:

$$\frac{42.3 \times 4.75 \times 471 \times 50}{33{,}000} = 143 \text{ I. H. P.}$$

Regarding suggestions, would advise that if your receiver from the high- to low-pressure is very long, you steam-jacket it. While it is the custom on western rivers to run the engines at slow revolutions, if the diameter of the wheels were somewhat reduced, so that the revolutions could be increased, more power would result from the same engine. Your speed of revolutions, however, seems to be about as high as any in practice. To divide up the power equally between the cylinders, it may be necessary to adjust the valves on the exhaust to the high-pressure, and the cut-off on the low-pressure. If you follow for full stroke on the low-pressure, you may find that the admission pressure in this cylinder is too low. This can be remedied by cutting off earlier in the stroke. A receiver pressure of about 20 pounds would doubtless be an approximation to the correct one. This question, however, can be best settled after the engine is built, by putting the indicators on the cylinders and taking cards off.

Q. 190.—In the October number, in Mr. McLane's article on the Template System, I beg to ask if you will advise how this may be carried out for applying to ships' plating? B.

A.—We have asked the author of the above article to reply to this question.—ED.

To lay off shell or inner bottom plating with molds, a mold about the size of the average plate you wish to lay off is required; the cross strip for frame spacing must be spaced accurately and be perfectly square with the edge of the mold. Short frame and seam battens will also be required. The frame batten is made from the corresponding section of the mold that is used to lay off the shell flange of the frames. The seam batten is made the length of one frame space, additional battens being made for butts at end of plates and where the adjacent strakes butt on the plate which is being laid off. All battens must be spaced off with dividers, so that the holes will be universal. There will also be a mold for butt holes, from which the butt straps may also be laid off.

As an example we will take a plate, *ABCD*, Fig. 2, forward of the lowest point in the sheer; let it be an outside plate in the sheer strake six frame spaces in length. Upon the frame batten mark the sheer heights at side of ship from the sheer pole, taking care to place them on the batten inverted. Fig. 1 shows frame batten

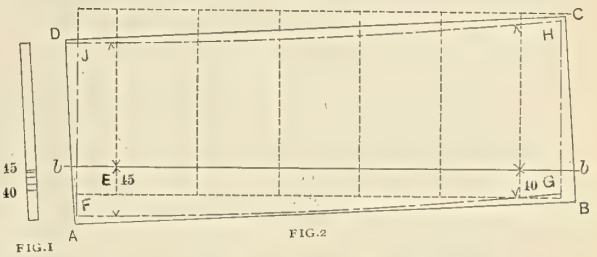


FIG. 1 FIG. 2

and sheer heights for one plate. The dotted lines in Fig. 2 show position of plate mold after being adjusted on the plate, and the dash dot lines the size of the final plate.

Proceed to lay off the plate by placing a spot on after end of plate at *E;* the distance from edge of plate to be equal to distance from 40 to 45 on frame batten plus a small amount as allowance for shearing, etc. Place plate mold on the plate holding the lower edge of mold to mark *E* on after end of plate, and to edge of plate at forward end. Then at a distance equal to the length of frame mold from the lower end to 40, strike a line, *bb*, parallel to lower edge of plate mold. Mark frame and butt stations across the plate by marking along the forward edge of frame station strips and remove mold from plate. The frame batten is now applied to the frame stations on the plate, holding 45 on frame batten at 45 *b*, marking frame holes and ends of batten. Mark remainder of frames on the plate in the same manner.

A long batten is now sprung through the marks made at the ends of frame batten and a fair line marked in, giving the outline of the finished plate *FGHJ;* the seam holes are now marked holding the seam mold to shearing line and frame stations. The butt holes are also marked from butt mold.

Only plates of slight curvature have been treated in this article; for laying off plates of much twist some complications arise requiring much care.

Q. 191.—Would you kindly advise me through your Queries and Answers column:

(1) Which is the right flag for a ship built and used in American waters, but owned by a foreigner?

(2) Is it required by law or by the insurance companies that the sailing master and the engineer of a 50- or 60-foot power launch should be licensed persons, and how are those licenses to be obtained? R. M. P.

A.—The ship mentioned in (1) has a right to American registry. If owners prefer, they can apply for registry under a foreign flag, and most any other government would give her registry if the proper application were made out and filed with said government.

It is required by this government that the engineer of your boat should have a United States license. This is obtained through the United States Steamboat Inspection Service, Bureau of Commerce and Labor, Washington, D. C. No master's license is required.

Q. 192.—Will you please figure out the horse power of a triple-expansion engine, with cylinders 12, 15, and 18 inches diameter by 16 inches stroke? The steam pressure is 185 pounds. Also, how many revolutions will the engine make? H. F. H.

A.—In the first place, your engine has an unusual ratio of cylinder diameters, the area ratio of high- to low-pressure being only about as 1 to 2 1-4, instead of about 1 to 6 or 7 as is usual. Thus the advantage of the three cylinders is lost, and you might as well take out the intermediate cylinder. It is impossible to state what revolutions you would get out of the engine, as that entirely depends on how high a piston speed it was designed for, whether a sufficient supply of steam is at hand, and the size and pitch of your propeller. In the absence of information on this, we will assume that the engine makes 150 revolutions. We also assume that it is run condensing and that the cut-off in the high-pressure cylinder is about 3-8 stroke. This early cut-off we suggest in view of the large high-pressure cylinder.

For finding the ratio of expansion and the mean pressure we will follow the solution of Q. 188. We find that this would give about six expansions, $r = 6$. Assuming that there is a drop of 8 pounds from your boiler to steam chest, the absolute initial pressure, p_1, is $185 - 8 + 14.7 = 191.7$, say 192 pounds.

$$P = p_1 \frac{1 + \text{hyp. log } r}{r}$$

From the table we find that for the ratio of expansion of 6 the reduction factor for mean effective pressure is .4653, and by substituting gives $P = 192 \times .4653 = 89.3$, the theoretical mean effective pressure. We assume that the card factor in this arrangement is only .55, which reduces the mean effective pressure to 49.1. Then using the formula for horse power we have:

$$\text{I. H. P.} = \frac{49 \times 1.33 \times 254 \times 150 \times 2}{33{,}000} = 151$$

TECHNICAL PUBLICATIONS.

The Practical Engineer Electrical Pocket Book and Diary for 1904. Size 5 1-2 by 3 1-2. Pp. 350, with 64 pages for diary on ruled sectional paper. Gilt edges, flexible cover. Price 1s. 6d. Technical Publishing Company, Manchester, England.

This book contains a good selection of engineering tables, formulæ, data, memoranda, and miscellaneous information which the electrical engineer is liable to need at any and all times, and also much special information on this subject. It embraces several articles on various conduit systems of wiring, on the comparative expense of operating hydraulic and electric elevators, and recent installations relating to new types of electric instruments.

The Gas Engine. By T. R. Hutton. Size 6 by 9 inches. Pp. 483, with 243 cuts and diagrams in the text. New York: John Wiley and Sons. Price $5.00.

This work is intended by the author to deal with that part of power-plant practice involving the use of gas engines. It is thus intended to form a companion volume to the author's previous work on the "Mechanical Engineering of Power Plants," from which a consideration of this part of the field was purposely omitted.

During the past few years there has grown up a largely increased appreciation of the possibilities of the internal-combustion engine of one type or another, and in particular of those types intended to utilize what were formerly called the waste gases from blast furnaces and the various grades of producer gas. The astonishing growth of small high-speed engines for use in automobiles and small boats is also an important aspect of the present movement in this field of engineering.

These facts the author has fully appreciated, and the work is therefore most timely, as a clear and fairly comprehensive treatment of the present condition of both the science and art of gas-engine design and operation.

In connection with design, however, it should be noted that the author purposely omits all consideration of the design of the gas engine as a mechanism. He believes that the general papers of machine design and the excellent treatises in this field cover sufficiently this part of the ground, and that he may better utilize his time in the consideration of the gas engine simply as a prime mover. The starting point is naturally the liberation of energy in the form of heat by the combustion of fuel, and the conversion of that heat energy into mechanical work. The cycle of operations which the heat medium undertakes, and the types of motor in which these various transformations occur, are considered in detail with special reference to the various kinds of fuel which may be employed. Consideration is then given to the details of mechanically mixing the fuel and the art of bringing about ignition, and the governing or controlling the development of energy in the cylinder in accordance with the demands for external work. Statements of the economic performance of the best designs of modern gas engines as determined by laboratory experiments are also included. In chapter xvii. is presented a very full theoretical analysis of the operation of the gas engine under all practicable forms of cycle. This forms the most comprehensive investigation of the subject from a theoretical point of view which has yet been published, and gives in convenient form large groups of formulæ suitable for almost every practicable case.

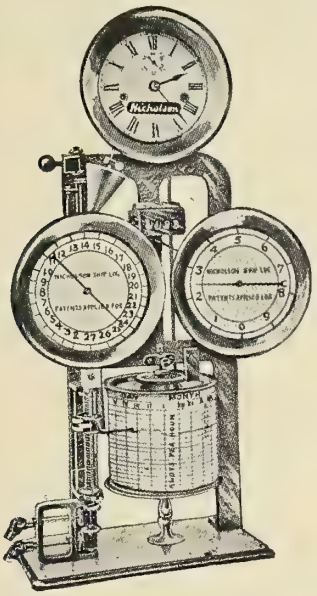
Attention is also given to the possibilities of the type of internal-combustion engine in which the heating takes place at constant pressure rather than at constant volume. The possibilities of the development of the gas turbine as a realization of this type of engine finds appropriate consideration in this chapter.

The book concludes with a brief historical summary of the development of the gas engine, together with a bibliography of the more important works on the subject.

As a whole the book is well written, the material is selected with good judgment, and it will form a most acceptable addition to the working library of every engineer who is interested in this field of power-plant practice.

SELECTED MARINE PATENTS.

742,215. SHIP'S LOG. EZRA NICHOLSON, LAKEWOOD, OHIO.



Claim.—1. In a ship's log, the combination with two pipes communicating with the water below the water line of the vessel, a float in each of said pipes, and a counterweight attached to each float, of indicated mechanism comprising a frame or support, a screw-threaded shaft operatively connected with one of the floats, a nut upon said shaft, a ring longitudinally movable in the frame and engaged by said nut, a sleeve upon the shaft and rotatively connected with said nut, and connections between said sleeve and the other float.

2. A ship's log, comprising means for admitting a column of water within a vessel so that the height of said column shall vary with the speed of the vessel, means for admitting a second column of water within the vessel so that the height of said column shall vary as the draft of the vessel, a screw-threaded shaft, a float on one of said columns operatively connected with said shaft to rotate the same as the height of the column changes, a disk upon said shaft, and a float on the other water column operatively connected with said disk, whereby the disk is moved lengthwise of the shaft proportionately to the relative variation of the heights of said water columns. Four claims.

742,216. SHIP'S LOG. EZRA NICHOLSON, LAKEWOOD, OHIO.

Claim.—1. In a ship's log, the combination with distance-registering mechanism, of a cone, means to rotate said cone regularly, a rotatable shaft operatively connected with said mechanism, a friction wheel operatively engaging said cone and rotatively mounted on said shaft, a sleeve on said shaft secured to said friction wheel, an arm connected with said sleeve for moving same lengthwise of the shaft, mechanism operatively connected with said arm whereby the sleeve is raised and lowered on the shaft the same distance for corresponding increases in the speed of the vessel. Seven claims.

742,326. MINIATURE OR TOY SUBMARINE BOAT. ALEXANDER F. HUMPHREY, ALLEGHENY, PA., ASSIGNOR OF ONE-HALF TO CHARLES R. BUCHHEIT, PITTSBURG, PA. Three claims.

742,450. LIFTING APPARATUS FOR RAISING OR LOWERING CANAL BOATS, ETC. RUDOLF KRELL, NUREMBURG, GERMANY, ASSIGNOR TO THE FIRM OF VEREINIGTE MASCHINENFABRIK, AUGSBURG UND MASCHINENBAUGESELLSCHAFT, NURNBERG A. G., NUREMBURG, BAVARIA, GERMANY.

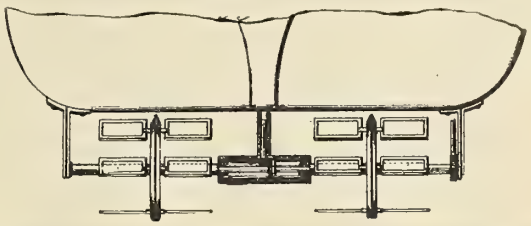
Claim.—1. In an apparatus for raising and lowering canal boats and the like, the combination with a framework, water troughs, and means for supporting said framework floating in said troughs, of drums mounted opposite one another in said framework and adapted to receive the boats or the like directly, and sluice gates completely closing the ends of said rolling drums, whereby the drums may be brought into communication with the canal troughs or may be closed completely at the ends. Two claims.

742,522. PROPELLING MECHANISM FOR VESSELS. TELEMAQUE T. TIMAYENIS, BOSTON, MASS. FILED MARCH 16, 1903. Four claims.

742,529. CURRENT WATER MOTOR. WILLIAM H. TRENCHARD AND FRANK HEATH, JAMUL, CAL. FILED JANUARY 13, 1903. Four claims.

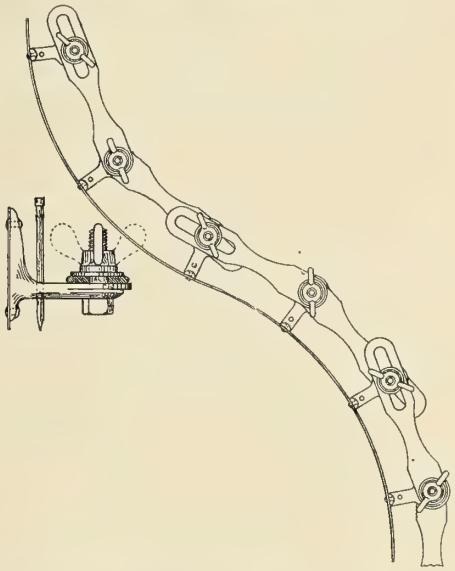
742,693. MARINE PROPELLER. CAREY A. MANKER, PEARL, ILL.

Claim.—1. An improved propelling mechanism comprising a central horizontal shaft, and rotatable blade carrier mounted thereon, blades journaled in said carrier, means for rotating them on their axes as they revolve bodily around the shaft, whereby their angles are varied as required, and means for retarding or accelerating the velocity of rotation of the blades in their down-



ward movement as compared with their upward movement. Four claims.

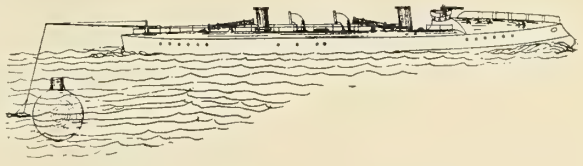
742,937. ADJUSTABLE TEMPLET FOR SHIPS' CARPENTERS. THOMAS B. WAY, JERSEY CITY, N. J.

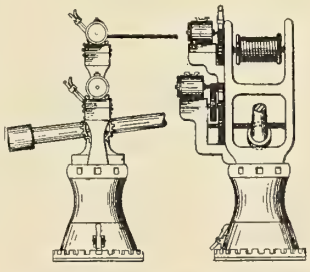


Claim.—The combination of the flexible band, provided with brackets rigidly secured thereto, each bracket provided with a perforation at its extremity, and perforated for the adjusting pin, the links each perforated at one end, and provided with a longitudinal slot at the other, and the fastening bolts each inserted through the perforation of one of the brackets and all serving to rigidly connect the links in series by means of the perforations and slots therein, and such series to the brackets. One claim.

743,055. WATER MOTOR. LARS E. BOOVIST, SEATTLE, WASH. FILED MAY 9, 1902. Five claims.

743,081. MINE OR SUBMARINE-BOAT DESTROYER. ALEXANDER F. HUMPHREY, ALLEGHENY, PA., ASSIGNOR OF ONE-HALF TO CHARLES R. BUCHHEIT, PITTSBURG, PA.





Claim.—1. In a mine and submarine-boat destroyer, the combination with a rotatable capstan, a supporting frame mounted on the capstan, shafts journaled therein, a boom arm mounted on one of said shafts and extending outwardly from the boat, means

connected with the other of said shafts and passing over said arm for supporting a torpedo, and means for actuating said means to raise and lower said torpedo. Four claims.

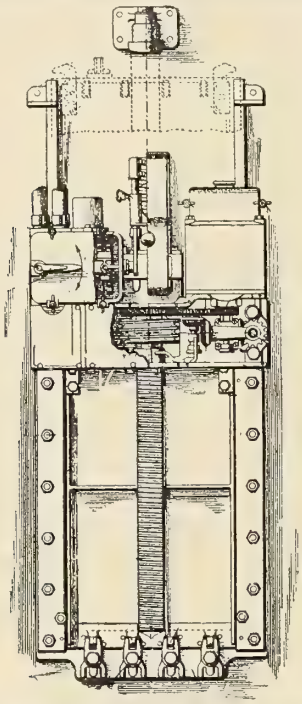
743,167. APPARATUS FOR LOADING VESSELS. CHRISTIAN J. INGARD, PORT TOWNSEND, WASH. FILED MAY 21, 1903.

Claim.—1. An apparatus for loading vessels comprising cables extended lengthwise of the vessel, a frame movable along said cables, and a sling movable on said frame transversely of the cables. Seven claims.

743,171. VESSEL. WALTER G. JAMIESON, UNION HILL, N. J. FILED MARCH 7, 1903.

Claim.—1. A vessel the hull of which is provided at the bow with a tube which is located longitudinally therein and the front end of which opens outwardly and forwardly through the cutwater below the water line, and the rear end of which opens downwardly and backwardly through the bottom portion of the hull at the bow end thereof. Three claims.

743,252. APPARATUS FOR OPERATING WATER-TIGHT POWER DOORS OR HATCHES. WILLIAM B. COWLES, CLEVELAND, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE CLEVELAND TRUST COMPANY, TRUSTEE, CLEVELAND, OHIO, A CORPORATION OF OHIO.



Claim.—1. In a system of the character described, the combination with a sliding door or hatch with a rack secured thereto, of a shaft capable of longitudinal movement when subjected to a longitudinal pressure, a gear wheel fast on said shaft and engaging said rack, an electric motor and gearing for driving said shaft, and an automatical cut-out operated by the longitudinal movement of said shaft for cutting off the current from the electric motor when the load on the motor exceeds a predetermined limit. Two claims.

743,265. ROWLOCK FOR BOATS. ALFRED FENWICK, SUNDERLAND, ENGLAND. One claim.

743,526. FOLDING BERTH. JOHN P. LEIN, NEW YORK, N. Y.

Claim.—In a folding berth, the combination with two fixed brackets having each a straight guideway and a headed trunnion projecting toward each other, of a berth frame having at each end a hanger comprising arms attached to the berth frame, and a web supported by the arms, said web having a curved T-shaped slot extending upwardly from the bottom and toward the rear of the berth frame, said T-shaped slot enclosing the head of the trunnion. One claim.

743,599. SHIP'S AIR AND LIGHT PORT. THOMAS UTLEY, LIVERPOOL, ENGLAND.

Claim.—1. In a ship's light and air port the combination of a hinged frame or shutter, means for enabling said frame or shutter to be shifted bodily in a direction approximately at right angles to the plane thereof, and means for locking said frame or shutter in its open position. Ten claims.

743,700. APPARATUS FOR PROPELLING AND STEERING VESSELS. JOSEPH DUPUIS, WOONSOCKET, R. I., ASSIGNOR OF ONE-HALF TO JOSEPH O. GIGUERE.

Claim.—1. In a propelling and steering apparatus for vessels, the combination of the hull of a vessel, a vertically-disposed sleeve fixed in the stern portion of the hull, an axially-movable, hollow post snugly fitting in the sleeve and having a flange disposed above the upper end of the same, anti-friction devices interposed between the flange of the post and the upper end of the sleeve, a shaft journaled in the lower portion of the hollow post, and carrying a propeller, and means, arranged in the hollow post, for transmitting motion to said shaft. Two claims.

743,721. MARINE LIFE-PAIL. HENRY H. HERRENDEEN, MUSKEGON, MICH.

Claim.—1. As a new article of manufacture, a marine pail adapted to serve as an ordinary pail as well as a life preserver, said pail being provided with an air chamber and a handle to serve as a hand-grasp at the bottom thereof. Four claims.

743,816. RECREATION SUBMARINE-BOAT DEVICE. FRANCIS W. BRADY, ENGLEWOOD, N. J., ASSIGNOR TO ELECTRIC BOAT COMPANY, NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim.—1. The combination, with a submergible boat, provided with means for closing it against the ingress of water to its inhabited part, with means for steering and propelling it, and with laterally-projecting parts to facilitate diving, of a guideway wholly submerged, having guides adapted to engage and take over the said laterally-projecting parts on the boat and draw the latter, as it advances, down under the water, said guideway thus having its entrance below the surface, so as to be invisible to spectators. Five claims.

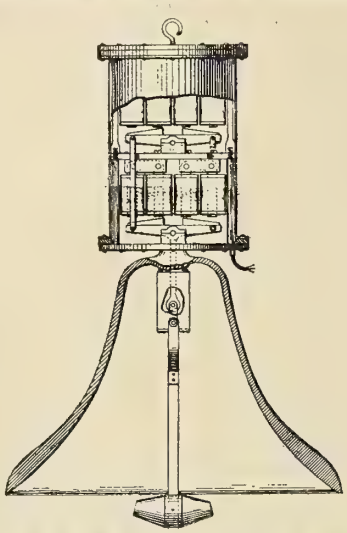
743,939. SAFETY-ALARM DEVICE FOR MARINE VESSELS. MARSHALL SHEPARD, EDGARTOWN, MASS.

Claim.—1. An alarm device for marine vessels, comprising an electric alarm, an electric circuit in which the alarm is located, a circuit closure in the vessel, a rod having swinging connection with the vessel, and a swivel-like connection between said rod and the circuit closure.

5. An alarm device for marine vessels, comprising a casing arranged in the hull of the vessel and opening therethrough, a valve for closing said casing, a cylinder removably arranged in the casing, a thimble arranged in the cylinder, a contact on said thimble and insulated therefrom. Five claims.

744,160. MEANS FOR TURNING OR SWINGING SHIPS WHEN NOT UNDER WAY. JOHN B. BLAIR, INDOOROPPILLY, QUEENSLAND, AUSTRALIA. Two claims

744,336. ELECTRICAL RINGING OF BELLS FOR SUBMARINE SIGNALING. ELISHA GRAY, HIGHLAND PARK, Ill., ASSIGNOR, BY MESNE ASSIGNMENTS, TO SUBMARINE SIGNAL COMPANY, A CORPORATION OF MAINE.



Claim.—1. As a means for producing in water sound-wave signals of high power for long-distance, submarine, wireless telephony, a submerged bell of large initial sound-producing capacity, a submerged hammer for powerfully striking the bell, each stroke of which is controlled, a submerged electric motor of large force to actuate the hammer in operative relation to the bell and hammer, the bell being in actual contact with the water. Five claims.

744,378. MEANS FOR CANAL-BOAT PROPULSION. GILBERT H. MANN, ZOAR, MASS. Six claims.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 90 vessels of 43,711 gross tons were built in the United States and officially numbered during the month of November, 1903. The largest steel steam vessels included in these figures are: *Mongolia,* 13,638 tons; *San Jacinto,* 6,069 tons; *J. L. Weeks,* 4,551 tons; *Lewis Luckenbach,* 3,905 tons; *Pere Marquette 19,* 2,626 tons; (sail) *William C. Douglas,* 3,708 tons.